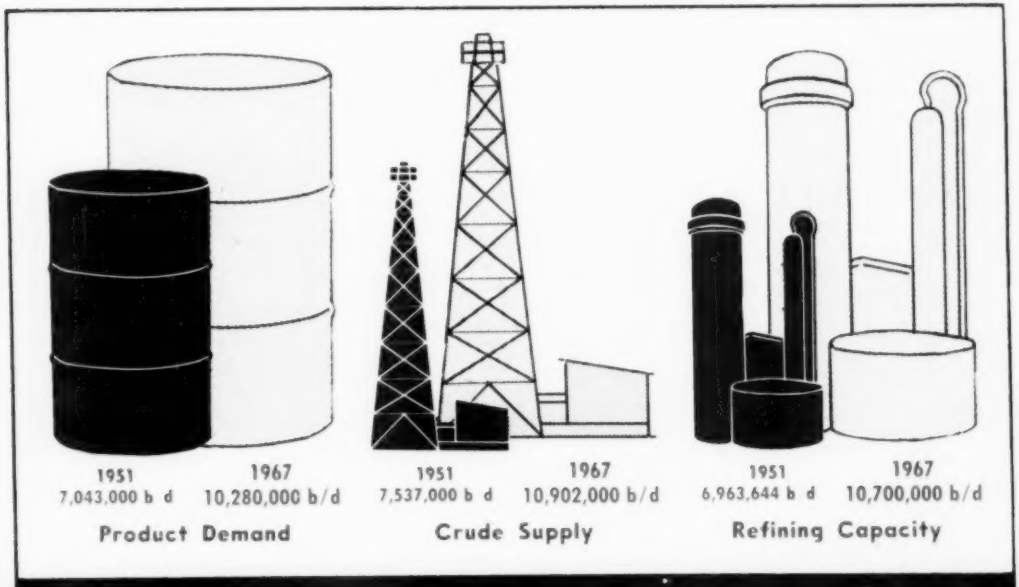
PETROLEUM PROCESSING

including Petrochemical Processing Section

NOVEMBER 1952



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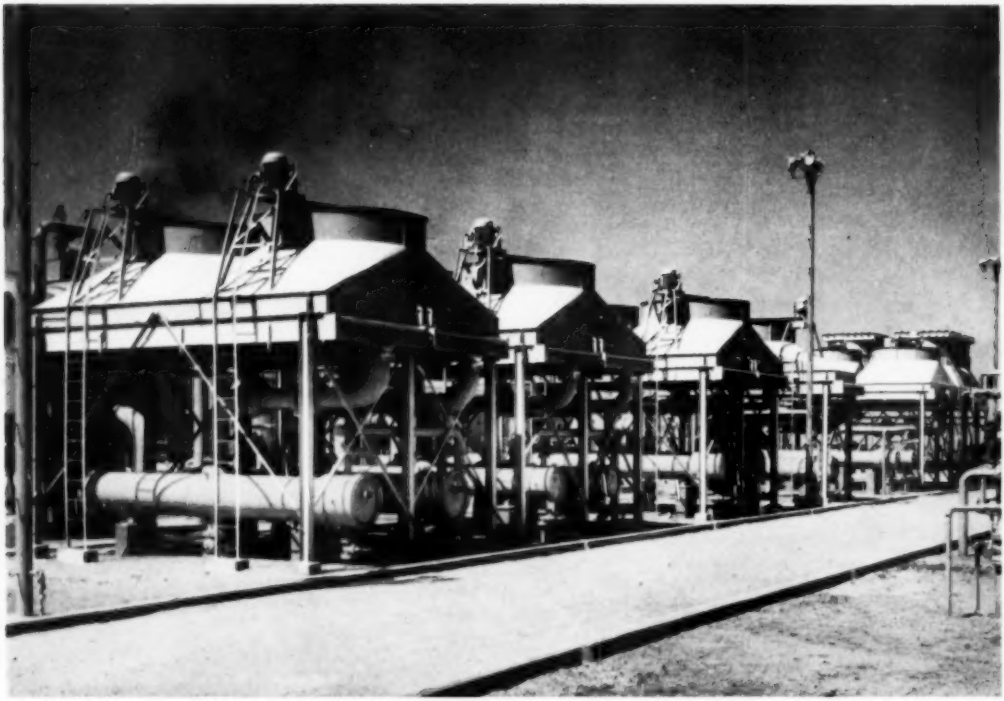

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Bulletins on HUDSON TOP PERFORMANCE cooling equipment mailed upon request.

At the Diamond M Sharon Ridge gas processing plant in Scurry County, West Texas, most of the heat from gas compressed in three stages is dissipated directly to the air in the SOLO-AIRE units shown above. Other SOLO-AIRE units are employed in this plant for oil cooling, acid gas condensing, still overhead condensing, propane and butane condensing, and jacket water cooling. In this and many other plants in water-scarce West Texas, Hudson SOLO-AIRE units have established their reputation for dependable, trouble-free operation.

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But you may not have noticed something extremely important about her crew. Every officer or man in a post of responsibility is a man of impressive experience. Her present skipper has been a ship master for thirty-two years. The chief engineer has been in engine rooms for 29 years. Even her executive chef has been in charge of ships' kitchens for 25 years.

In an operation as complex as sailing a great liner . . . or serving a great industry . . . there is simply no substitute for experience. And it is interesting to note that most of the men at the helm of the company which supplies the petroleum industry with the major part of its antiknock compound requirements are men who have been with Ethyl for upwards of twenty years.

(Continued on next page)

ETHYL
ETHYL CORPORATION

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Something you may not have noticed about the S.S. United States

(Continued from preceding page)

For example: The man in charge of manufacturing at Ethyl has been with us for 26 years. The head of technical services has had 23 years of Ethyl experience; the vice-president in charge of sales started with Ethyl 26 years ago; and all four regional sales managers have more than twenty-two years of service.

Is it any wonder that Ethyl appreciates and understands the problems of refining, distributing and selling petroleum products? So, whether the going is rough or smooth—and the oil industry has gone through plenty of stormy weather—you can rely on experienced Ethyl people to be on deck when you need them.

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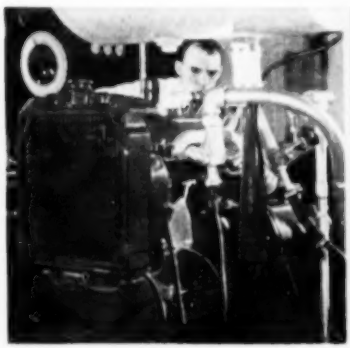

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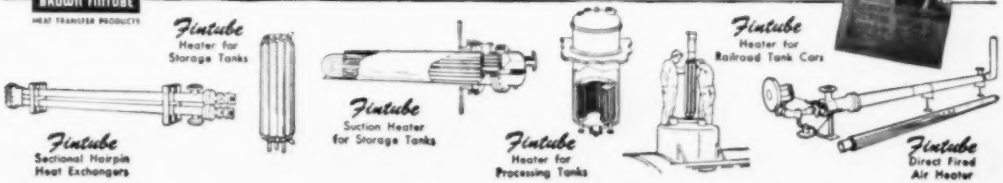
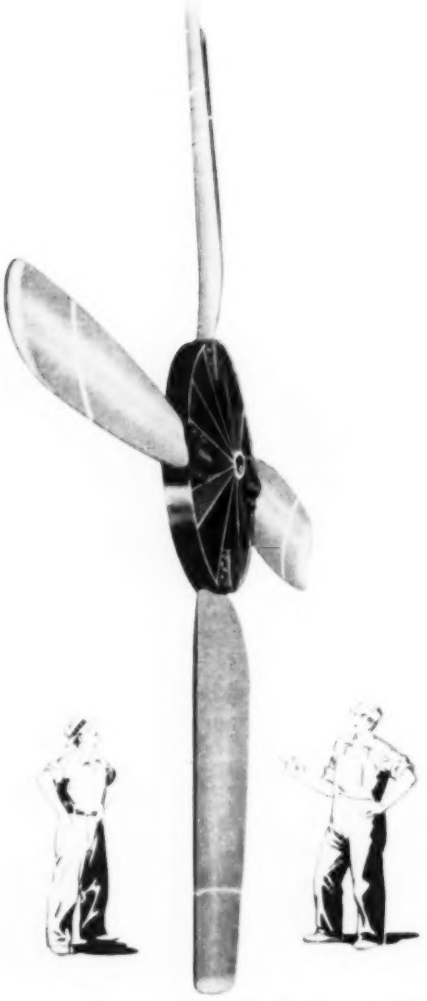


How to identify

A GOOD COOLING-TOWER FAN



Get the records of as many batteries of large cooling towers as you can — towers which have been operating a long time. Ask what fans were originally furnished. If any have been replaced by Hartzell fans, ask what fan will be used if more of the original fans go bad. If the originals were Hartzell, ask how they have performed.

You'll get *facts*, not claims.

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November, 1952
Vol. 7, No. 11

PETROLEUM PROCESSING

Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

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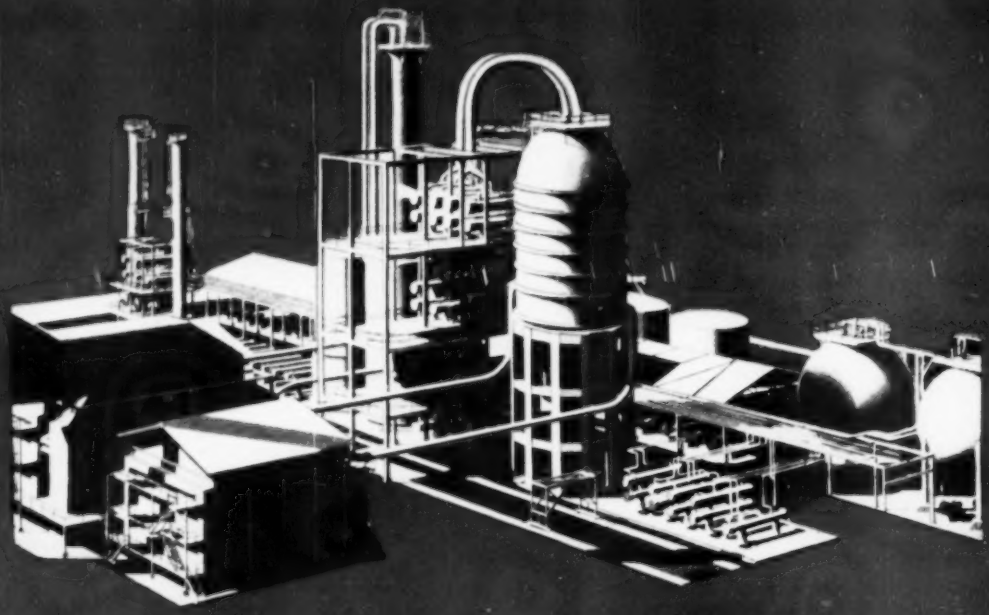
crude distillation units



125,000 bbls/day

The unit illustrated above is an artist's drawing of probably the largest two-stage crude distillation unit in the world, now being designed and constructed by Foster Wheeler for the Gulf Oil Corporation at the Girard Point, Philadelphia refinery . . .

. . . but, whether 125,000 bbls/day, 25,000 or 1000 bbls/day FW know-how is at work for the refiner —as it has been for over 30 years—designing, fabricating and constructing more than 600 processing units of all types and capacities.

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PETROLEUM PROCESSING

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Your reading habits—as members of the general public—may well have been changed considerably in recent years, because it has become so much easier for you to get news on current events from such sources as radio and television.

However, your reading habits as members of the highly technological petroleum industry have certainly turned to an increased study of today's technical and industrial magazines—judging from your answers to our recent readership surveys.

You are not only reading more magazines that tie in with your job, but you are also reading each magazine more thoroughly. And, you are reading not only the editorial material but you are also reading the advertisements.

This is good.

The value you can obtain from PETROLEUM PROCESSING, for instance, is easily doubled by including every page from cover to cover in your reading. Frequently, your first information on a new piece of equipment, a new material of construction, a new process, or a new service comes to you in an advertisement.

Webster defines advertising essentially as public notification or information or instructions. And that pretty well defines the advertising you find in PETROLEUM PROCESSING.

Your benefits from reading the advertisements is further enhanced by the fact that they have been directed toward you and your own problems. Because you have been made a member of a rather exclusive club—hand-picked men in the petroleum and petrochemical processing industries—the advertisements can be designed more precisely with you in mind. The people who create these "public notifications" are aiming with a rifle at a sharply defined bullseye. They are not forced to fire a load of buckshot at a miscellaneous flock of geese, ducks, pheasant, etc., hoping to hit only the most select birds.

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What's Happening . . .

Expansion

. . . **Total refining capacity by 1967** should be about 10,700,000 b/d, according to 15-year forecast of supply and demand presented at annual meeting of American Petroleum Institute this month in Chicago. Domestic demand for products by then should have risen to 10,280,000 b/d, which will be met by crude runs of 8,763,000 b/d, natural gas liquids output of 1,065,000 b/d, and some product imports. Complete forecast (by Swearingen and Boatwright of Indiana Standard) appears in this issue, starting on p. 1605.

. . . **Refining survey by Bureau of Mines** shows gain of 369,241 b/d in refining capacity during 1951, to bring total to 7,332,885 b/d on Jan. 1, 1952. This includes 171,519 b/d of shut-down capacity. Bureau found there were 350 refineries at beginning of year, seven less than a year ago. Additional capacity of 286,680 b/d was under construction Jan. 1, Bureau reported. Free copy of report, IC 7646, is available from Bureau's Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

. . . **Expansion of U. S. lube oil capacity** has been slowed down by refinery expansion abroad and possible loss of foreign lube markets. Although PAD expansion program goal is 15,000 b/d, only five projects have been approved for rapid tax write-off with total capacity of 2,426 b/d, with no other applications on hand, according to PAD official.

Projects approved for tax write-offs are: Shell Oil Co., Houston, 350 b/d; Deep Rock Oil Corp., Cushing, Okla., 900 b/d; Sun Oil Co., Marcus Hook, Pa., 525 b/d; Standard Oil Co. of Calif., Richmond, Calif., 232 b/d; Sinclair Oil Co., Wellsville, N. Y., 419 b/d.

. . . **A new refinery in eastern S. Dakota** has been proposed by Leonard Wudel, of Wudel Oil & Gas Co., Indedendent jobber at Mitchell, S. Dak. Wudel proposes to organize a corporation of Independent oil men soon to promote project, to assure Independents of sure and constant source of supply, to make residual fuel available to the state "on a competitive basis" and to eliminate dependence on Group 3 rail rates. Possible site suggested has been Pickstown, on Missouri River, with crude from Williston Basin being barged down.

. . . **Cities Service Oil Co. (Del.)** will spend $11 million on modernization and expansion program at its 35,000 b/d East Chicago, Ind., refinery, to be completed by end of 1954. Included are crude topping of over 30,000 b/d cap city to be built by Arthur G. McKee & Co. and catalytic reforming of over 12,000 b/d. Existing delayed coker unit will have capacity approximately doubled.

. . . **Humble Oil & Refining Co.** will install a 28,000 b/d solvent deasphalting unit, reportedly of unique design and twice as large as any previous deasphalter, at its Baytown, Texas, plant. It will prepare additional clean feed stock for catalytic cracking from vacuum reduced crude. M. W. Kellogg Co. has design and construction contracts and construction will start as early in 1953 as materials procurement will allow.

. . . **Standard Oil Co. (Ohio)** has authorized installation of a 12,000 b/d Platforming unit at its Lima, Ohio, refinery, designed primarily to increase high octane gasoline production but also providing for aviation gasoline manufacture later. Universal Oil Products Co. is designing unit on basis of company's letter of intent, but contracts have not been let. It is planned to break ground next May, completing unit a year later.

. . . **British American Oil Co.** is planning an $8 million expansion of its Clarkson, Ont., refinery. Included are catalytic cracking, catalytic polymerization, gas concentration and other facilities. This will be the fourth major expansion of B-A refineries in past five years.

Petrochemicals

. . . **An expansion goal for acetic acid** has been set by Defense Production Administration, calling for 740 million lbs. annual capacity by Jan. 1, '55. This represents an increase of 107 million lbs. over Jan. 1, '51 capacity. Although some acetic acid is still produced as a by-product of hardwood distillation, principal source is from oxidation of hydrocarbons or ethyl alcohol.

. . . **Grace Chemical Co.** has been formed as a wholly-owned subsidiary of W. R. Grace & Co. to handle the parent company's petrochemical activities. Grace's new $18 million ammonia-urea plant (see What's Happening, Oct. '52, p. 1367) will be built on a 277-acre site in the Woodstock, Tenn. area, approximately six miles from Memphis. Davison Chemical Corp. will act as advisor on engineering and other matters during the construction period.

. . . **Monsanto Chemical Co.** has awarded United Engineers and Constructors, Inc. contract for construction of its new phenol plant at Avon, Calif. Construction of manufacturing facilities is to begin shortly; site preparation and service facilities having been under construction since July. (See What's Happening, Sept. '52, p. 1216).

. . . **Allied Chemical & Dye Corp.'s** Nitrogen Division is awaiting Federal Power Commission approval of its contract for natural gas supply with Northern Natural Gas Co. before starting construction on a proposed ammonia-urea fertilizer plant at La Platte (Omaha), Nebr. Catalytic Construction Co. has already been awarded major construction contract pending FPC approval, and it is contemplated that Girdler Corp. will design and erect the gas reforming and purification equipment.

. . . **Brea Chemicals, Inc.** has been formed as a wholly-owned subsidiary of Union Oil Co. of Calif. to

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

develop, manufacture and market petrochemicals. Marketing activities and personnel of Union's By-Products Chemical Division, originally established for petrochemical sales within the parent company, will be transferred to the new organization. Temporary executive headquarters will be at Union's research center at Brea, Calif., with sales offices at 714 West Olympic Blvd., Los Angeles.

. . . **Phillips Chemical Co.** is placing the first commercial plant for manufacturing methyl-vinyl-pyridine on stream at its Pt. Adams petrochemical plant on the Houston Ship Channel. Raw materials are ammonia and acetaldehyde, both from petroleum. Other products will include picolines, lutidines and mixed pyridines.

. . . **Consolidated Chemical Industries** has broken ground adjacent to Humble Oil and Refining Co.'s Baytown refinery for construction of a sulfuric acid plant. The plant will utilize hydrogen sulfide and certain acid sludges (previously burned) recovered from refining processes in the Baytown refinery. Partial operations are scheduled to commence within eight months, full scale production scheduled for the last quarter of 1953. It will be the second plant in the Houston Ship Channel area to use refinery wastes in an effort to combat air and water pollution. Shell Chemical's 55 ton/day sulfur recovery unit having just begun operation.

. . . **General Tire & Rubber Co.** is studying plans for large-scale expansion into petrochemicals. Recent reports are that the company's chemical division has underway "economic studies and building plans that spell out a $60 million plant expansion for producing petrochemicals and derivatives."

Industrial Mobilization

. . . **New alkylate expansion program** of 31,000 b/d is being considered by PAD and military. Program would incorporate untilled balance of 23,000 b/d of current program. Meanwhile, PAD officials from Deputy PAD J. Ed Warren on down have been contacting companies personally to enlist support of avgas program. Chief point being made is that avgas demand will continue upward at least until 1958, contrary to somewhat general feeling that it will fall off as military turns more and more to jet aircraft.

. . . **Underground storage of jet fuels** is being actively studied by military. Armed Services Petroleum Purchasing Agency has awarded contract to Don. C. Stewart of Wichita, Kans., for experimental underground storage of 60,000 gal. of jet fuel. If jet fuel experiment is successful, other petroleum products will be tested in Kansas salt cavern storage facility, which has already been tested privately with LPG.

. . . **Synthetic fuels expansion program** is being put together by Bureau of Mines, at request of DPA. Although not yet completed by end of month, Bureau was expected to suggest following growth in output of synthetic fuels:

1953—7,000 b/d from natural gas synthesis plant of Carthage Hydrocol at Brownsville, Texas.

End of 1954—10,000 b/d from oil shale facilities.

End of 1955—15,000 b/d from coal hydrogenation facilities, and 10,000 b/d from additional gas synthesis facilities.

End of 1956—40,000 b/d more from oil shale.

. . . **If you've received a fast tax write-off** and there's a difference in completed plant from description given in original application, here are standards DPA and Internal Revenue Bureau have agreed on:

1—If facility is the same as that certified, even though actual cost exceeds estimated cost on certificate of necessity, Revenue Bureau will accept it.

2—Also, even though facility varies from that certified and actual cost exceeds estimate by not more that 15%, Revenue will accept it.

3—Where variation from certificate is more extensive than above, company may apply to DPA for amended certificate. If DPA approves change, it then notifies Revenue.

. . . **Copper shortage still exists,** according to nation's producers of copper wire and cable mill products. Last month they told National Production Authority they have 5-month backload of orders, and urged government to quit stockpiling copper until industry can catch up with industry orders.

. . . **PEOPLE—Harris Bateman** (chief engineer for Cities Service Oil Co., Bartlesville) has replaced **Richard M. Morrison** as director of PAD Materials Division . . . **Thomas C. Keeling, Jr.** (Koppers Co.) has been named director of NPA's Chemical Division, after serving since Sept. 19 as deputy director.

Markets, Prices

. . . **Refining operations held at high level** all through October—made possible by continuing strong demand for gasoline in most areas and, after a few false starts, improved call for distillate fuel oils.

. . . **Prices were firm, with few exceptions,** and No. 2 fuel was quoted 0.125c higher, at 7.625c on the low, for Oklahoma tank car shipment. Spot heavy fuel still was being sold at "distress" levels of $0.725 to $0.75 per bbl. in the Mid-Continent, and No. 6 fuel in transports was quoted 0.1c lower at 5.6c per gal. in the Chicago refining district.

At the Gulf Coast, No. 2 fuel in cargo lots mostly was held, at 8c, for regular-customer buyers. On the other hand, full distillate storage along East Coast led to 0.25c "discounts" on some sales of No. 2 fuel at New York harbor. "Low" rates on foreign flag tanker voyages from the Caribbean to North-of-Hatteras points also tended to undermine prices for bunker fuel at middle Atlantic terminals.

. . . **Specialty product sales were more spotty** than those of principal products—as were also specialty prices. LPG and Grade 26-70 natural gasoline were virtually the only specialties to meet with good demand at generally posted quotations, whereas solvent lubricating oils, petrolatums and refined waxes all were suffering from flagging export requirements.

Solvent refined bright stock was quoted 1c lower at the Gulf for bulk shipment, at 31c per gal., and this price was said to be subject to shading on firm bid.

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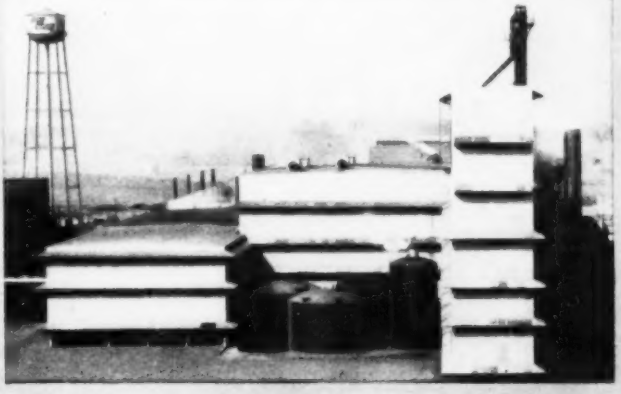
ST. REGIS PAPER CO., *by using Insul-Mastic Type "D", the Coating that Insulates and Protects,* will prevent up to 65% of heat loss from these black liquor tanks and foam tank. Many other vessels throughout this modern new mill at Pensacola, Florida are coated with Insul-Mastic for corrosion prevention as well as insulation.



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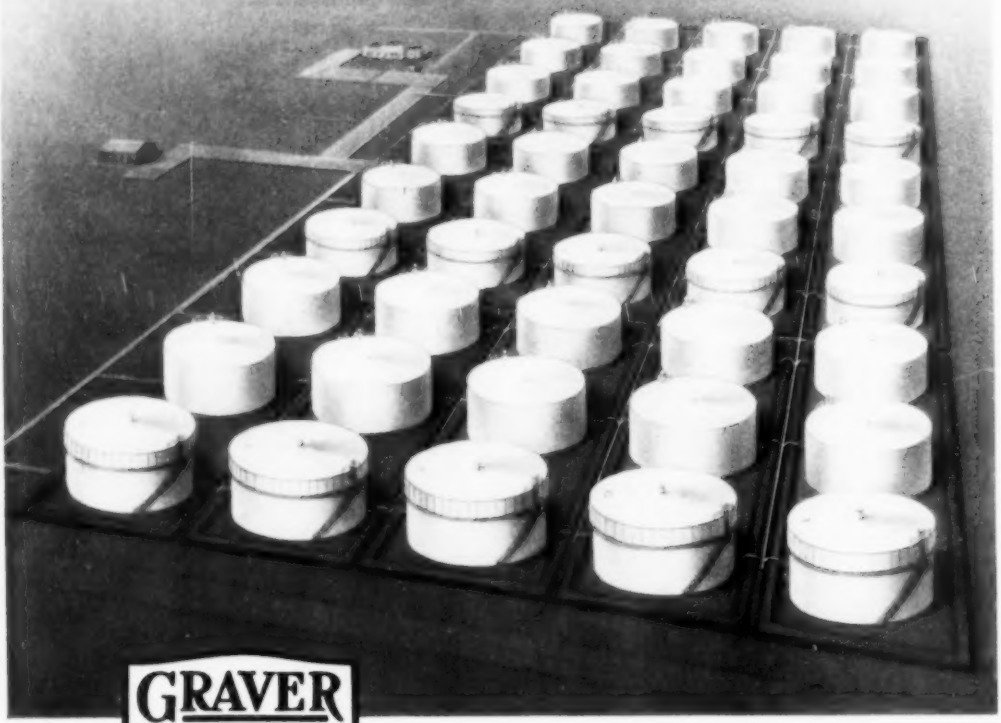

GRAVER

This mammoth terminal of fifty 80,000-barrel tanks—rarely duplicated in any actual installation—represents the extraordinary record of product savings accomplished by the many Graver Expansion Roof systems throughout the country in the dozen years since the design was introduced to the petroleum industry. According to currently accepted evaporation loss factors, it is conservatively estimated that the Graver Expansion Roof has saved 168,000,000 gallons of gasoline—a gallon for every man, woman and child in the United States.

GRAVER TANK & MFG. CO., INC.

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Underground Cavities May Be An Answer to LPG Storage Problem

UNDERGROUND, or sub-surface, storage of liquid hydrocarbons may yet become an economic solution to the LPG industry's problem of meeting a fluctuating demand for its product.

One oil company reported recently[1] that costs for such storage lie in the range of 50c to $2.00 per bbl. of storage required. This compares very favorably with current costs for above-ground pressure storage, which run between $15 and $20 per bbl. In addition to the straight economics, conventional tankage uses large amounts of critical steel, is dangerous, cumbersome, expensive to maintain, and becomes an unused "white elephant" during periods of high demand.

Any liquid in which salt is not soluble can be stored in underground reservoirs; liquefied petroleum gas was a specific example used by the oil company. Suitable areas for sub-surface storage are widespread, not only at production points, but also in the vicinity of industrial centers and the heavily populated sections of the East, it was said.

Payout can be realized in from one to five years, depending upon the product stored and the market price at recovery date. Losses can be kept relatively low, around 4% or lower, under conditions of proper design.

A salt bed washed out by water to form an open cavity was used in the example reported. The installation was made at a stripping plant in Texas. Water was used at the rate of just under 6 bbl. per bbl. of storage cavity formed. Size of the finished cavity was approximately 60,000 bbl. Actual cost per bbl. of space was calculated to 77.6c. This takes into account all material for drilling, circulation, surface installations (less a dehydrator) and all other expense directly chargeable to the project. The company believes a second reservoir of equal size could be made for about 50c bbl.

Cost figures of this caliber won't be ignored for very long. The storage problem is always present in an industry which has a situation of constant flow and variable demand. —W.C.U.

(1) "Sub-Surface Storage of Liquid Hydrocarbons," Neal E. Van Fossan, field engineer, Slick-Urschel Oil Co., Midland, Texas, presented at Petroleum Mechanical Engineering Conference of the American Society of Mechanical Engineers, Kansas City, Mo., Sept. 22-24, 1952.

125,000-Bbl. Processing Units For Refineries of the Future

LARGE scale combination catalytic type processing units (125,000 b/d capacity or even larger), starting with crude oil, are a possibility for refineries of the future, according to engineering authorities with M. W. Kellogg Co., refinery engineer-contractors.[1]

"Of great, and not at all thoroughly scouted significance," they state, "is the possibility of extending the principle of combination type units to include the new catalytic type process techniques. With catalytic type processing of petroleum fractions as compared to thermal processing, it has been found possible to extend run lengths very considerably thus enhancing the potential merits of combination processing."

With such plants, economies in investment and operating costs could be achieved. No process limitations appear to these authorities to stand in the way of building units to 125,000-b/d. capacity, with obvious savings over five 25,000-b/d. units. Large savings can also be anticipated in connection with auxiliary facilities including such items as intermediate storage tanks, among other equipment." It is estimated that future complete refinery installations may call for an investment only 80% as great for offsite facilities as for process equipment, while in the past offsite facility costs have generally exceeded those of process equipment."

Associated processes which might be integrated into combination unit design are listed, omitting those which might adversely affect overall stream efficiency: Crude topping, vacuum distillation, solvent decarbonizing or coking, catalytic cracking, alkylation, catalytic polymerization, catalytic reforming, caustic washing, treating, and so on.

As these authorities themselves point out, one presently known limitation to the extension of catalytic cracking to residual fuels or whole crude, is the fact that catalysts have not yet been developed which can maintain their activity in the presence of contaminants such as are found in some crudes and heavy fuel oils. Considerable research work is going on in the development of better catalysts.

Of more importance in the immediate future, it is reported, will be new processes for residual fuel or reduced crude oil. The four main processes for such treatment are given as (1) vacuum distillation, (2) solvent decarbonizing, (3) thermal visbreaking, and (4) thermal coking. "Since the coking process produces the highest yields of light ends," it is stated "it probably will be the one to receive the greatest future development. Another advantage of coking is that metallurgical coke is in increasing demand for the rapidly expanding aluminum industry."

—V.B.G.

(1) "The Future of Petroleum Processing," P. F. Swanson, manager, process engineering dept., and N. R. Adams, manager, refinery plans division, M. W. Kellogg Co., New York. Before American Chemical Society, Atlantic City, Sept. 14-19, 1952.

Esso Brings Out New Oil to Reduce Engine Wear Caused by Friction

FOLLOWING the recently reported research work of Standard Oil Development Co., pointing to friction as the main cause of cylinder wear in passenger car engines,[1] Esso Standard Oil Co. has recently introduced in commercial sales its Uniflo Motor Oil, "especially recommended for the modern automobile engines, particularly those with high compression ratios and close tolerances".[2]

Use of the new type oil, it is claimed, will help the engine give new-car performance for a longer period and reduce wear to make the engine last longer. It is available in a single viscosity grade to be used all year around under all temperature conditions.

"A survey of engine re-builders and dealers repair shops," it is stated, "has shown that wear is wholly or partially responsible for 85% of all engine over-

hauls. High oil consumption, power loss and reduced performance all result from large clearances that occur when engine parts are worn. Newly developed research techniques, using the electron microscope and radioactive tracers, have shown that wear is caused by friction, abrasion and corrosion; and these new techniques make it possible to identify the different types of wear.

"Each type of wear leaves a definite pattern, or 'finger print' on the metal surface. In passenger cars, friction wear is most important; being primarily responsible in 51% of the cases studied. It has been found that a thinner (lower viscosity) oil reduces friction wear."

Because of its high viscosity index, the Uniflo oil is said to meet four SAE viscosity classifications—5W, 10W, 20W and 20.

Corrosion, termed the least important cause of cylinder wear, can be cut in half, it is claimed, with the detergent type of additives contained in the new oil. Referring generally to combustion chamber deposits as increasing the octane requirement of the engine, it is stated that the new oil has certain properties which inhibit building up deposits in a clean engine.

Other companies are marketing engine oils tailored to reduce cylinder wear without, however, as far as is known, assigning the cause of wear as primarily due to friction at high operating temperatures. The growing appreciation of what engine wear costs the public in overhauls, regardless of the cause, and the new research techniques available for wear studies, will undoubtedly lead to future improvements in engine design or lubricants, or perhaps in both fields.

—V.B.G.

(1) "Friction, Main Cause of Engine Wear," PETROLEUM PROCESSING, Sept. 1952, pp. 1282.
(2) "The Newest Thing for New Cars for Cars in New Condition," Esso Marketer, published by Esso Standard Oil Co., Oct., 1952, pp. 8.

Turpentine May Become Source of Synthetic Low-temperature Lubes

DEPARTMENT of Agriculture and Navy chemists are developing methods of making satisfactory low-temperature lubricants from turpentine and other pine-tree products.

Some of the results of joint research between Agriculture's Bureau of Agricultural and Industrial Chemistry and Navy's Office of Naval Research are described in a recent news release.(1) Specifically, the principal component of turpentine, alpha-pinene, is oxidized to the dibasic pinic acid. This, in turn, is esterified with normal alcohols containing from four to ten carbon atoms per molecule to form a series of dialkyl pinates.

Seven different pinates believed especially valuable as low-temperature lubricants have been synthesized, including the diamyl, dihexyl, diheptyl and dioctyl pinates, and subjected to tests. The four named have freezing or pour points below minus 75°F.

As the chain lengthens, there is a progressive increase in the viscosity of the normal pinate diesters, from 7.1 cs. at 100° F. for the butyl to 20.9 for the decyl ester. The pinates fall in the same viscosity range as aliphatic diesters made from sebacic, azelaic and adipic acids, all of which now are widely used in making synthetic lubricants (which acids also are needed in nylon and plasticizer manufacture).

Further tests indicated good response to typical oil antioxidants, rust inhibitors and other additives. Engine tests appear promising and a blend of mineral oil with synthetics and additives is now in use under Arctic conditions. Stable lubricating greases have been made.

The principal problem now under investigation is the development of a low-cost method of making pinic acid from alpha-pinene.

Net result of all this work may well be that oil refiners will have less pressure put on them by the military for special lubricants, while at the same time being able to provide better specialty lubes for their own non-military customers through the compounding of these new synthetics with the natural variety.

—D.P.T.

(1) "Lubricants from Pine Trees," by C. M. Murphy, J. G. O'Rear and W. S. Zisman, News Release No. 415-52, Dept. of Defense, Office of Public Information, Washington 25, D. C., and further information supplied to PETROLEUM PROCESSING.

Bureau of Mines Stepping up Studies Of Catalytic Refining of Shale Oil

THE Bureau of Mines is getting set to run demonstration-scale tests on catalytic processes in the refining of shale oil at its Rifle, Colo., installations and has let a contract to Catalytic Construction Co. to design a unit, presumably to hydrogenate distillates and reform naphthas and gas oils. A recent technical paper by a Bureau scientist(1) reports that catalytic cracking is not feasible because of poor yields, catalyst poisoning and excessive coke deposition.

Costs are not reported, but on the basis of tests with a 200 b/d thermal cracking and chemical treating plant it is indicated that acceptable gasoline can be produced by thermal recycle cracking of the crude oil and chemical treating. The light naphtha is caustic-washed. Heavy naphtha is successively washed with 15% caustic soda and 15% sulfuric acid, then treated in a three-stage countercurrent step with concentrated sulfuric acid (20 lb. per bbl.) followed by re-running. Gases are polymerized.

The resulting gasoline, in a yield of about 44 vol.-%, when blended with 13 vol.-% of Grade 26-70 natural gasoline, tests 76 octane Motor Method and 84 Research with 3.0 cc. TEL. Calculations indicate an ultimate yield of about 49 vol.-% by adding coking.

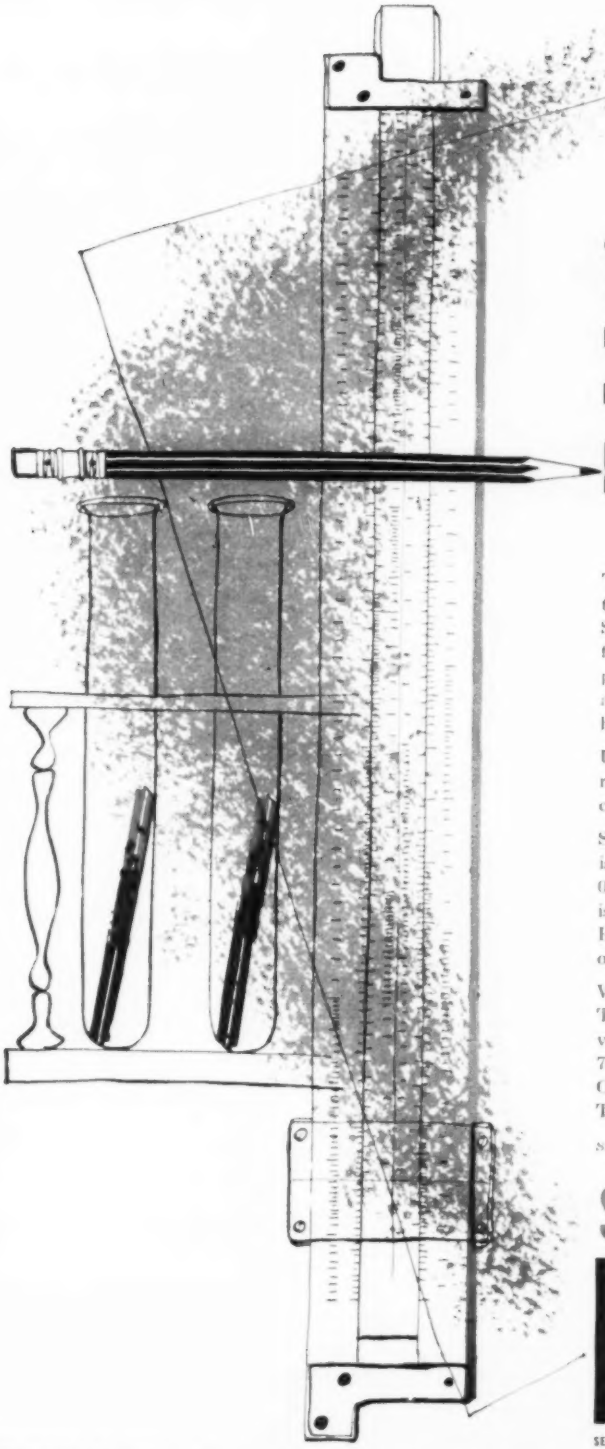
The Bureau now wants to try hydrogenating the light and heavy distillates, comments that hydrogenating the total crude appears unfeasible because of the high pressures, expensive equipment and operating costs. Low pressure is used in distillate hydrogenation.

The hydrogenated distillate resembles middle distillates from sweet Mid-Continent crudes and yields good quality Diesel and jet fuels in 40:60 proportion. It may be catalytically cracked in the conventional manner. Hydrogenate yield of 85-87 vol.-% on crude appears attainable.

With a reported 100 billion bbls. in a 1000 sq. miles of Colorado mountains, the Bureau feels the U. S. has 40 years' supply at present consumption rates for liquid fuels. But the actual cost of selling it in Podunk—and not Bureaucrat figures either—is going to be of most interest to U. S. oil companies and John Q. Public.

—D.P.T.

(1) "Shale Oil Refining Techniques," by J. D. Lankford, U. S. Bureau of Mines, Rifle, Colo., presented at Oklahoma State meeting, American Institute of Chemical Engineers, Tulsa, Oct. 11, 1952.



TESTS PROVE

NEW

MONSANTO ADDITIVE

INHIBITS RUST

Testing has conclusively proved the effectiveness of Monsanto's new additive, Santolube 70 rust inhibitor. Laboratory and field test results on its corrosion-preventive properties show Santolube 70 to be adaptable to use in turbine oils and oils used in hydraulic and circulating systems.

Uniquely, Santolube 70 protects against rusting and does not adversely affect copper, admiralty and other metals.

Santolube 70 is economical to use, too. It is effective in concentrations ranging from 0.02% to 0.10%. Usually the lower dosage is ample protection for light turbine oils. Higher concentrations are used for viscous oils or whenever salt water is present.

Write for Technical Bulletin No. 0-86. This gives test results, typical inspection values and other information on Santolube 70. MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 800 North Twelfth Blvd., St. Louis 1, Missouri.

Santolube Reg. U. S. Pat. Off.

SANTOLUBE 70

MONSANTO
CHEMICALS – PLASTICS

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(To obtain more data on advertised products see page 1680)

Controlled Pressure

for efficient operation

Clark Pressure Reducing and Regulating Valves

are precision made for positive pressure control on air, gas or steam lines.

Where different types of equipment, with varying pressure requirements, are operated from a common line, Clark Regulating Valves can be depended on to deliver automatically the "just right" pressure to each.

Save on fuel, maintenance and protect expensive equipment. Ask your Clark representative to specify the right Clark valves for your needs . . . or write us direct.

TYPE KRV

Pressure Reducing Valve. Diaphragm Operated, Single Seated Valve. Sizes ¼" to 1½" for initial pressures up to 250 P.S.I. Reduced pressures to 85 P.S.I.

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Pressure Reducing Valve. Integral pilot controlled piston operated. For pressure control from "dead end" to full capacity. Sizes ½" to 6".

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Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3". 150 P.S.I. For pressures to 250 P.S.I.

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The complete line of dependable fluid controls

Letters

Laboratory Safety

Mr. Jacobsen's list of the six safety problems to consider in analytical research was informative and possibly novel. ["Make Your Research 'Lab' Safe," Sept., pp. 1267-9]. However, his last item, Training of Workers, would make or break the other five. It is our experience that over 85% of accidental injuries are suffered by non-technical personnel, many of them inexperienced and with incomplete training.

Self-correction of hazards is an ideal arrangement—if the worker can recognize the hazard and then clear his solution through the proper authorities. Many make-shift corrective measures are inadequate or expensive. Another important training problem is engendering responsibility for the safety of fellow workers, as mentioned by the author.

In discussing sample and solvent handling, the author pointed out that the size of the sample affects the attitude toward its hazard of toxicity or flammability. Many codes for chemical and solvent handling apply to plant operation rather than laboratory procedures, and are therefore of limited usefulness unless modified. Furthermore, the amount of solvent or chemical that can be kept safely in a laboratory depends upon many physical conditions and the types of containers used. Nothing can contribute more to safe operation than careful planning of work by responsible technical people. . . .

The author wrote almost exclusively about analytical research operations. I would like to have discussions on pilot plant work and other bench scale operations.

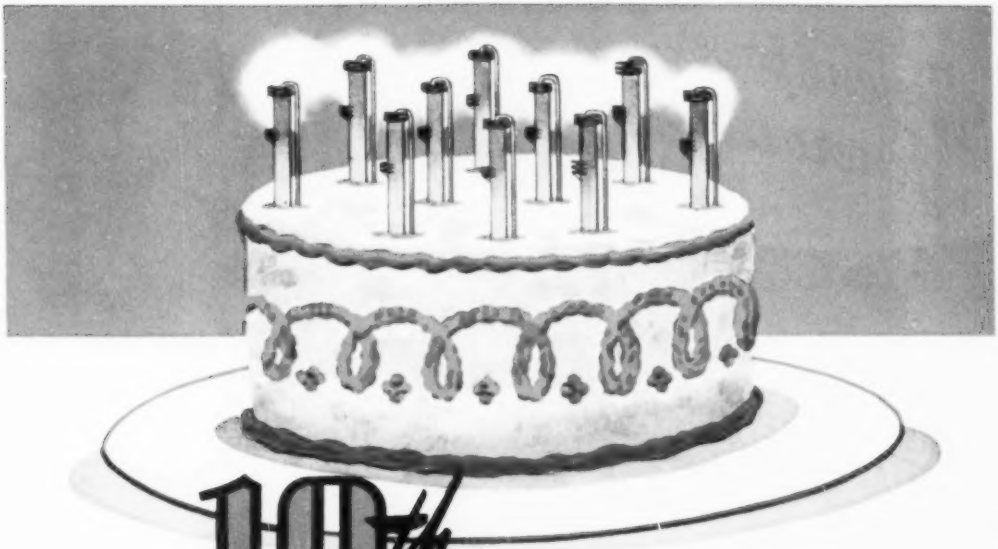
WILLIAM S. WOOD
Research and Development
Safety Committee
Sun Oil Co.
Marcus Hook, Penna.

Friction vs. Corrosion

. . . our general thinking is that corrosion is probably the main contributor [to engine wear] rather than friction. ["Friction—Main Cause of Engine Wear," Sept. issue, pp. 1263-6]. This is based largely on the work of others who have been stressing wear reduction by the use of acid neutralizing oils.

J. R. SABINA
Technical Manager
Organic Chemicals Dept.
Petroleum Chemicals Div.
Du Pont Co.
Wilmington, Del.

A review of the evidence favoring the corrosion viewpoint appears in this issue, p. 1620.—Ed.



OUR 10th ANNIVERSARY OF BUILDING *BETTER* REFINERIES

Just 10 years ago, we received our first contract for remodeling the polymerization plant of the Ashland Oil & Refining Company of Ashland, Kentucky. This was followed by other contracts. This year, we have contracts for seven new cat crackers, as well as for other refinery construction. We are proud to state that we have had additional contracts from Ashland as well as nearly all refiners for whom we have done work.

We have just prepared a brochure with information about our company and the work we are doing. Write for a copy on your company stationery, and one will be mailed you promptly.

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. for efficient power generation

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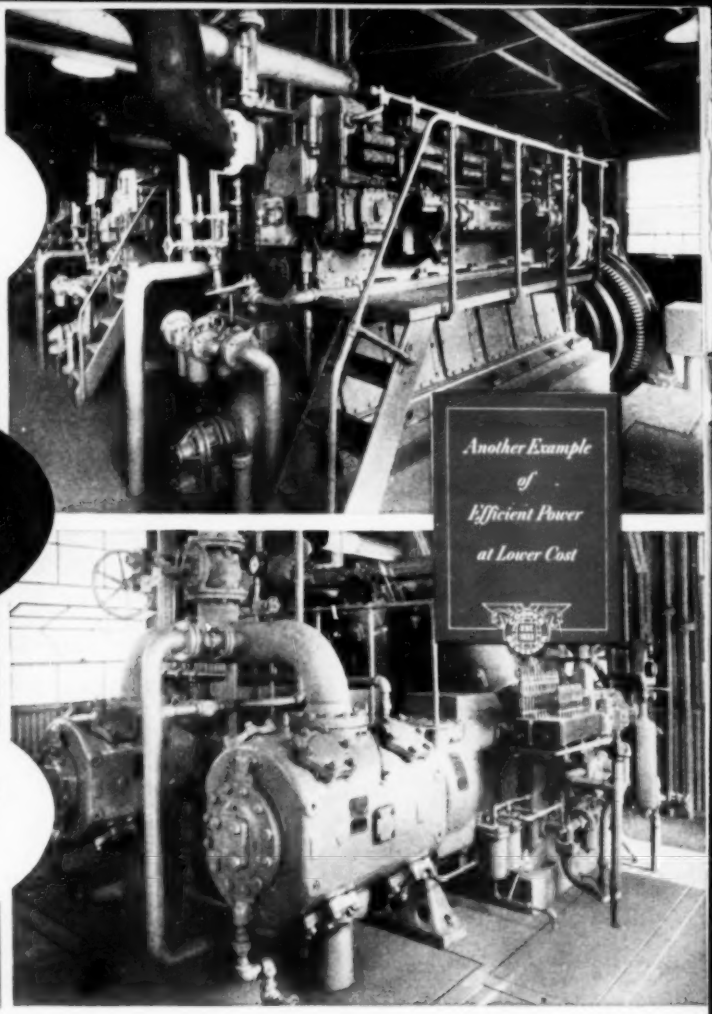
Cooper-Bessemers ALL THE WAY



The new natural gasoline plant of the Hugoton Plains Gas and Oil Company, now operating about a year, is powered by the Cooper-Bessemer units shown above. These consist of three JS-6 540 hp gas engines driving 368 KW A.C. generators, and a 308 hp GMX V-angle compressor.

This interesting field processing plant, engineered and constructed by J. F. Pritchard & Company, serves 176 gas wells, operates without steam, and efficiently produces natural gasoline, propane, butane and iso butane. Residue gas goes into Northern Natural's system.

The three JS gas engines operate 24 hours a day, furnish all electric power required to operate the plant. Using Cooper-Bessemer's latest development in high compression operation, these modern engines attain 34.4% thermal efficiency, holding fuel consumption to less than 7400 BTU/bhp/hr.

The GMX is used as a propane refrigeration unit. And here, as in other processing services, this modern Cooper-Bessemer V-angle compressor is showing a consistent record of trouble-free, low-cost performance under continuous operation.

Whether your plans call for power generation, compressing, or both, check on the advantages you stand to gain with the latest Cooper-Bessemer developments.

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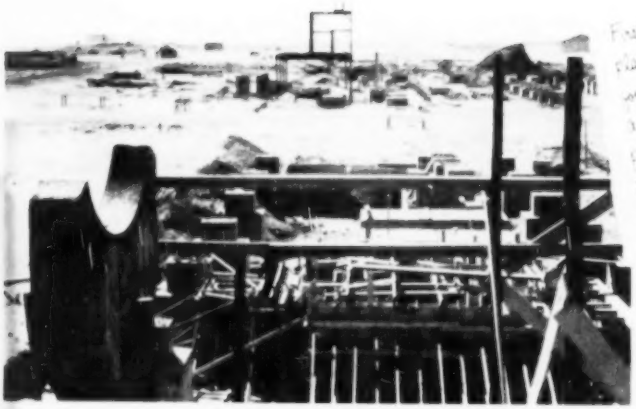
PROGRESS REPORT
for November, 1952
KELLOGG
Round the World with
Kellogg Construction Crews

PROGRESS REPORT for November,



First catalytic cracking unit in Kellogg plant in with Kellogg moving-bed construction under way and structural steel already in place. The $6 million plant employing Kellogg-Systech process is the first commercial unit of its kind.

In the Southwest another important modernization program is beginning to take shape. A major unit is to be installed at an Oklahoma Fluid catalytic cracker. Here a crawler crane is employed in the erection of a pedestal for a guy derrick.

Design work on two more Kellogg-built units will continue with completion scheduled for 1952. The units will comprise a reactivator, topping and vacuum towers. The reactivator of the 30,000-BPD unit is shown in the foreground.

1952...continued...

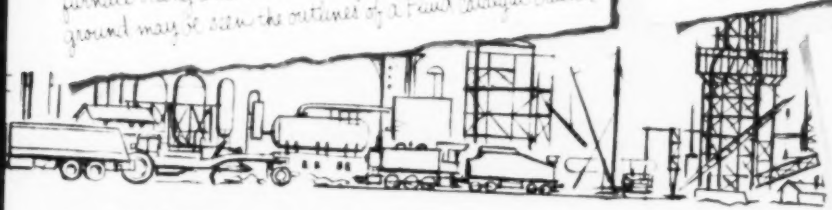
(PHOTOS SHOW ACTUAL FIELD CONDITIONS AS OF OCTOBER 1, 1952)

KELLOGG

Rated at approximately 13,000 BPD reactor throughput a unique Fluid catalytic cracker is being erected in Philadelphia. This view shows recovery and unassembled units over-all. Next picture reveals progress in structural work on main fractionator and catalyst storage drums

On Argentina's complete 28,500 BPD refinery is moving steadily along. Furnace stacks totes rear of the vertical furnace while totes main crude furnaces. In the background may be seen the outlines of a Fluid catalytic cracker

One of nearing a score of Kellogg projects is in the pre-drawing stage on the West Coast. Pre-cast cement piles are being driven down to bed rock for this immense plant. One of its features will be Kellogg-designed reactors



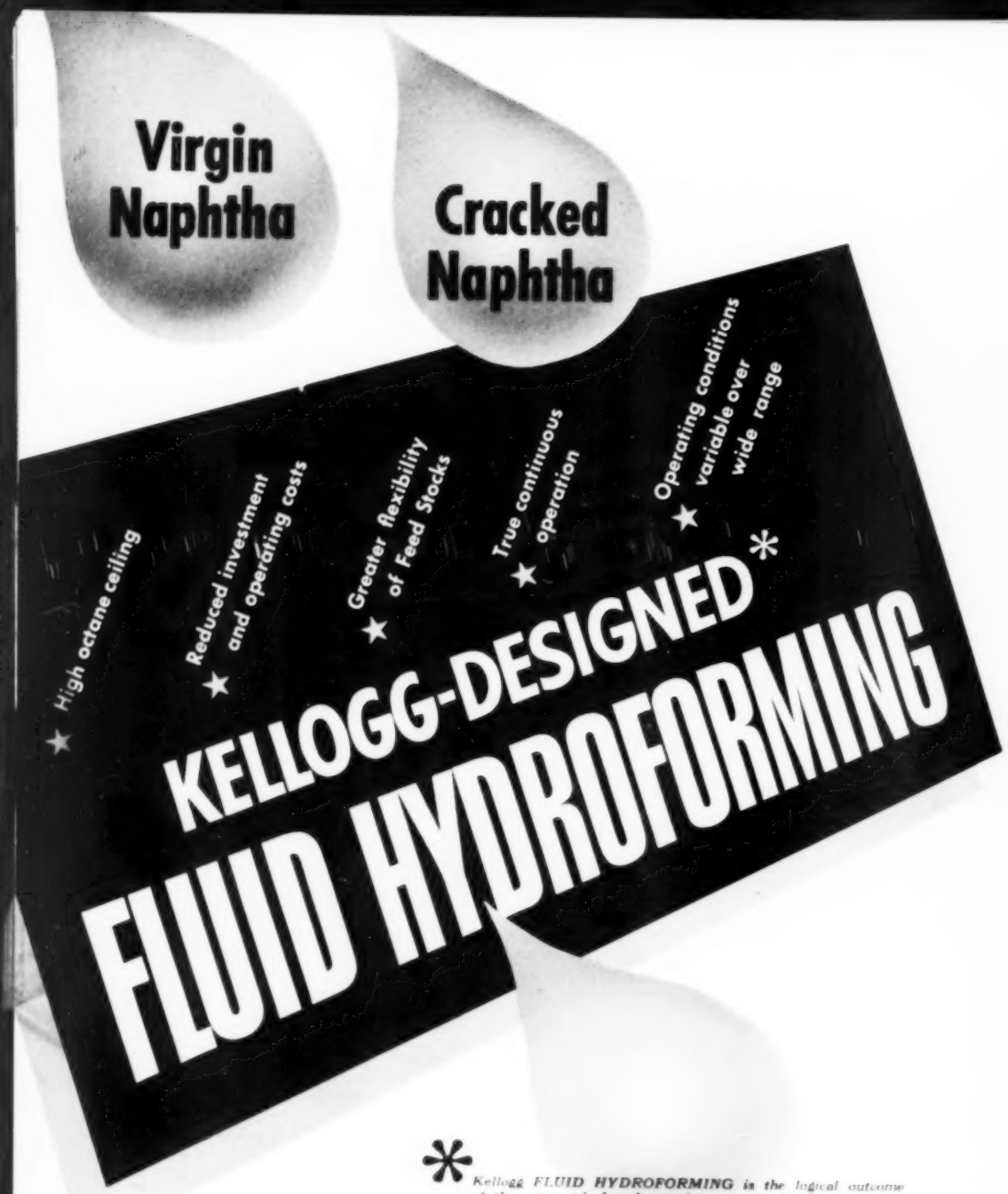
PROGRESS REPORT CONTINUED ON THIRD FOLLOWING PAGE . . .

IMPORTANT!

See next page for message about FLUID HYDROFORMING

M. W. KELLOGG

ROUND THE WORLD WITH KELLOGG CONSTRUCTION CREWS



* *Kellogg* ***FLUID HYDROFORMING*** *is the logical outcome of the company's* ***broad experience in the*** *fields of fixed bed Hydroforming* ***and Fluid catalytic*** *cracking.*

Kellogg ***designed and built the*** *first Hydroforming unit in 1940, and has designed and built all but one of the subsequent units . . . more than 90 percent of world capacity. In the field of Fluid catalytic cracking, Kellogg has engineered an annual capacity of better than 350 million barrels.*

Comprehensive data on Fluid Hydroforming for both naphtha upgrading and aromatics production—from the company's own pilot plants and from all other authoritative sources—is available to Kellogg customers.

First to go on stream . . .
will be this Fluid Hydroformer for a Gulf Coast refiner. It is scheduled for completion this month. Two others are now being engineered by Kellogg—one to be located in Louisiana and the other for the Mid West.

Each brings the advantages of efficient fluid catalyst techniques to the upgrading of naphthas . . . each is engineered to provide great flexibility in choice of operating conditions.

Catalyst level in the reactor can be varied over wide limits. The turbulent catalyst bed serves to improve catalyst-feed contact, and also functions as an important aid in temperature control. Steady, uninterrupted production of desired quality may be maintained continuously on any given feed stock, since fresh catalyst is introduced as necessary to maintain desired catalyst activity and selectivity.

Fluid Hydroforming provides higher octanes from low quality naphthas. And since it is a continuous, regenerative process, it is adjustable to a variety of feed stocks from hexanes (for benzene production) to kerosene, including virgin heavy naphthas, high-sulphur cracked naphthas and mixed virgin-and-cracked feed.

Fluid Hydroforming is not only more economical in operation but also requires a lower initial investment than comparable fixed-bed equipment. If you are considering expansion or renewal of naphtha processing facilities, a study of Fluid Hydroforming advantages will be rewarding.

Actual commercial operating data from this first plant will soon be available. But meanwhile, a Kellogg bulletin, "FLUID HYDROFORMING", gives detailed pilot plant data on performance of the process in handling virgin, coker and mixed naphthas from several different crudes. Copy will be mailed on request.

THE M. W. KELLOGG COMPANY

for fifty one years an integral part of petroleum refining progress!

M KELLOGG W PULLMAN

Reduced Pre-Cracking

Here, the Kellogg-designed reactor is lifted onto its concrete pedestal at a time when the unit was more than 80% complete.

High Octane Ceiling

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

PROGRESS REPORT for November,

In Ohio the pedestal for a large Orthoflow Fluid catalytic cracker has been poured. The job includes considerable other new equipment as well as modification of existing units.

Almost ready to go on stream is the world's largest Fluid Hydroformer at Destrehan, Louisiana. Here the reactor is being hoisted into place. The pump house and control room are to the left of the fractionating towers. Completion is scheduled for this month.

1952...continued...

(PHOTOS SHOW ACTUAL FIELD CONDITIONS AS OF OCTOBER 1, 1952)

The excellent progress being made on this job in Canada is readily apparent. The inset shows the site in May. The main units, both the largest of their kind in the Dominion, are Fluid cracking and combination atmospheric and Vacuum distillation

The British Isles are the scene of major activity in the erection of Kellogg-designed units. One of several different projects, this 17,500 vacuum flasher is now being furnished in Scotland. The main furnace is shown to the right while in the foreground is the water cooler.

Shielded against the raw Welsh winds workers continue work on the regenerator of a 10,000-BPD Fluid cracker for a British refinery. In other parts of the Isles, construction crews are erecting two additional catalytic crackers as well as other refining and chemical plants.

PROGRESS REPORT CONCLUDED ON NEXT PAGE

M. W. KELLOGG

PROGRESS REPORT for November, 1952

KELLOGG

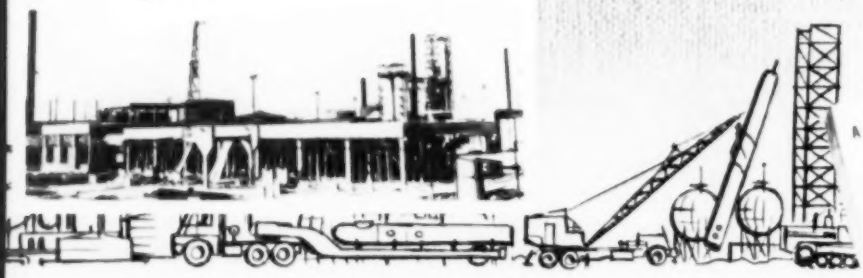
In Illinois most of the foundations are in place and steel work is going up for the 10-million-pound alcohol plant. The new unit will produce 10 million pounds annually.

This all-unit facility (start to finish) will be the world's largest Phenol-from-Cumene plant. Its big reactor (second from left) is pictured at the right as it arrived at the site. Other units will produce Cumene, Phenol, Acetone, Alpha Methyl Styrene.

In Italy a chemical reactor (shown above) was just completed at press time. To improve the overall petrochemical rating of the country, this catalytic poly-reaction unit is the latest construction. It is partially packed control house is on the left. (see below)

OTHER MAJOR CONSTRUCTION PROJECTS IN WORK

- Alkylation Plant — *U.S. East Coast*
- Cat Poly Unit — *Scotland*
- Complete Refineries — *One for Chile; one for Iraq; two for Brazil*
- Deasphalting Units — *two, U.S. Southwest, England*
- Decarbonizing Unit — *U.S. Southwest*
- Desalting Unit — *U.S. East Coast*
- Fat Splitting Unit — *Norway*
- Fluid Hydroforming Units — *two, U.S. Gulf Coast, Midwest*
- Olefin and Petrochemicals Plant — *Italy*
- Orthoflow Crackers — *two, U.S. East Coast, Canada*
- Phenol-from-Cumene Plant — *U.S. East Coast*
- Phenol Treating Unit — *U.S. Southwest*
- Phthalic Anhydride Plants — *two, England, Italy*
- Solexol Decolorizing and Fractionating Unit — *Norway*



A KELLOGGRAM HAS JUST BEEN ISSUED WHICH FEATURES KELLOGG CONSTRUCTION OPERATIONS—IF YOU HAVEN'T RECEIVED YOUR COPY JUST DROP A LINE TO 225 BROADWAY, NEW YORK

ROUND THE WORLD WITH KELLOGG CONSTRUCTION CREWS

Make it *your* policy to use Tenamene 60 —the protection is worth many times the cost!

COPPER contamination costs you money by accelerating the rate of gum formation.

Its presence in gasoline, even in extremely low concentrations (1 ppm), necessitates the use of excessive amounts of gum inhibitor and can result in costly reruns.

Since copper contamination results from such minor occurrences as the corrosion of admiralty tubes in condenser bundles, its presence in gasoline is the rule rather than the exception.

Don't take chances with copper in your gasoline—deactivate with Tenamene 60. The cost is negligible—under most conditions the addition of 0.5 pounds of Tenamene 60 to 1000 barrels provides adequate protection—approximately 0.002 cents per gallon. Tenamene 60 can be added along with your regular gum inhibitor.

be safe— be sure— insure with—

Tenamene 60 EASTMAN COPPER DEACTIVATOR

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TENNESSEE EASTMAN COMPANY *Division of Eastman Kodak Company* **KINGSPORT, TENNESSEE**

In the heat of things.....

USE

BIGELOW-LIPTAK THIN WALLS IN REFINERY VESSELS

Today's streamlined refinery vessels utilize Bigelow-Liptak abrasion-resistant thin walls for low and medium temperature applications.

Vessel linings of this type provide a well-balanced heat enclosure. Initial costs, as well as maintenance and costly outage time, are substantially reduced while efficiency remains high.

Like all Bigelow-Liptak construction, thin walls are unit suspended. Refractories are hung from castings which, in turn, are supported by the steel shell. Insulation effectively blocks heat drains and by passing. Walls can be adapted to cylindrical, conical or spherical vessels.

Flexible, thin walls are used, not only for refinery vessels, but for boiler walls, dryer furnaces, cement clinker coolers as well as many other applications.

Important!... **A new bulletin describing the history of B-L thin walls is now being published. Reserve your copy today.**

BIGELOW-LIPTAK *Corporation*

and Bigelow-Liptak Export Corporation

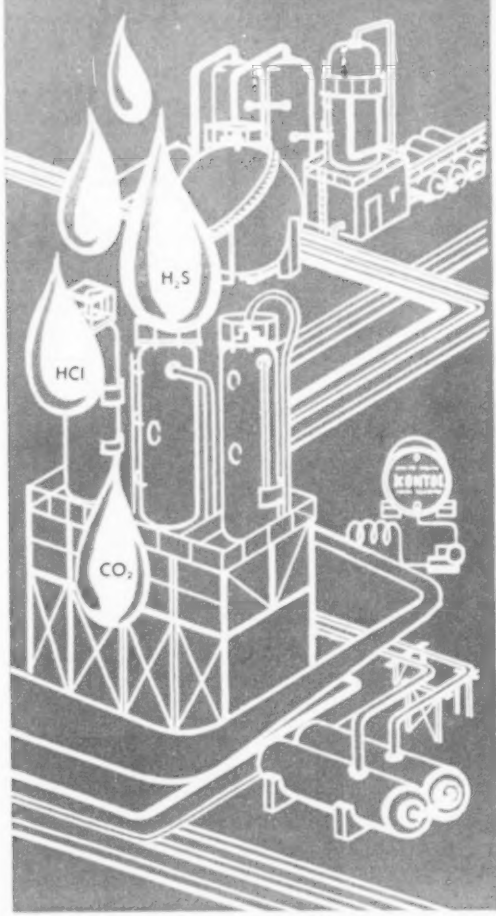
2550 W. GRAND BLVD. • DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: Bigelow-Liptak of Canada, Ltd., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SAULT STE. MARIE, MICH. • SEATTLE • TULSA • VANCOUVER, B.C.

STOP CORROSION LOSSES



KONTOL

Corrosion Inhibitor is used effectively in the refinery to combat corrosion caused by moisture, chlorides, HCl, CO_2, H_2S and organic acids. Kontol inhibits attack by H_2S, stopping blister formation at its source.

KONTOL can be used to control the corrosion of flow lines, fractionating towers, debutanizers, depropanizers, and stripping columns. It is also effective in the protection of heat exchangers, gathering systems, separators, scrubbers and overhead products lines.

KONTOL does not affect the quality of refined products, with reference to end point, gum-formation, anti-knock rating, color, ash content and so on.

KONTOL can be continuously injected into a refinery flow system by means of a chemical feed pump, or by once-a-day batch injection by means of a lubricating device.

KONTOL provides protection against corrosion by adsorbing at metal surfaces as a thin, tough, impervious film which prevents contact by corrosive agents. It provides substantial protection against many kinds of refinery corrosion which, heretofore, have been accepted as being unavoidable.

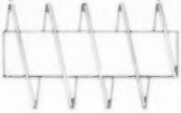
For a prompt survey of your corrosion problems by a Tretolite Company refinery engineer, write or call the

CORROSION INHIBITING • DESALTING
DEHYDRATING • WATER DE-OILING
SCALE PREVENTING

TRETOLITE COMPANY
SAINT LOUIS 19, MISSOURI
LOS ANGELES 22, CALIFORNIA

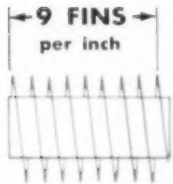
yes WOLVERINE TRUFIN* is available also in ALUMINUM

in 5 FINS per inch



7 FINS per inch

9 FINS per inch



11 FINS per inch

Efficient . . . economical . . . compact . . . light-weight—four valuable assets in any heat-transfer application. Aluminum Trufin meets *all* these requirements.

Because of its integral fin construction—Trufin can withstand extreme temperatures and severe vibration without affecting heat-transfer efficiency.

Actual applications have revealed that the heat-transfer efficiency of Trufin is sometimes *nine times* greater than plain tube! In many instances the use of Wolverine Trufin has resulted in low-cost installation and maintenance with maximum heat-transfer efficiency.

Aluminum Trufin is light, it's durable, and it's as easy to fabricate as plain tube!

Aluminum Trufin is available in hard or soft tempers, and in a variety of sizes—with inside diameters ranging from 3/16" to 1",

Send for your copy of Wolverine's Bulletin dealing with Trufin and heat-transfer.

WOLVERINE TUBE DIVISION

Calumet and Hecla Consolidated Copper Company

Manufacturers of tubing exclusively

1425 CENTRAL AVE. DETROIT 9, MICH.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

*REG. U. S. PAT. OFF.

Wolverine manufactures Trufin condenser tubes in copper and copper base alloys and bi-metal in a variety of fin spacings and fin heights. —also plain condenser tubes in copper and copper base alloys.

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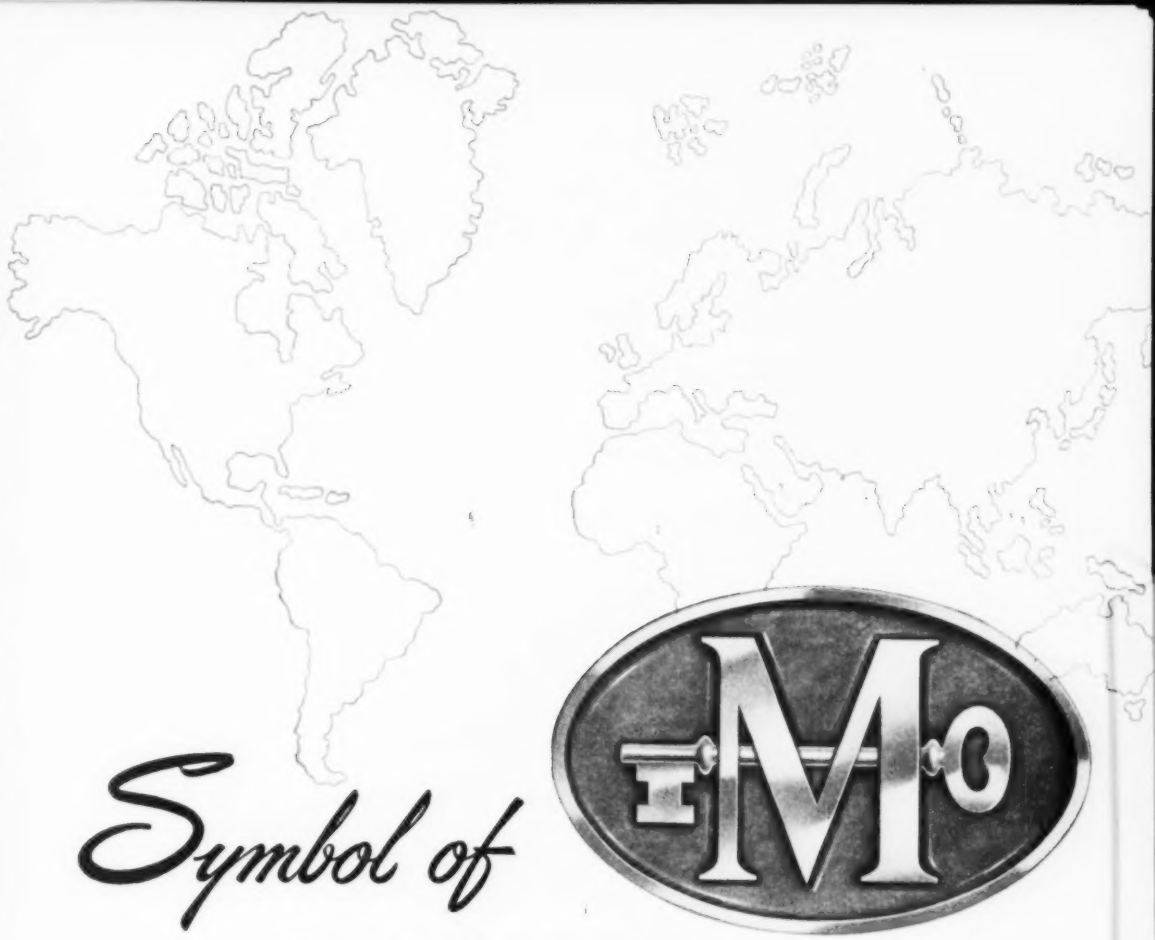
Export Department: 13 E. 40th St., New York City 16, N.Y.



Symbol of

ENGINEERING INTEGRITY

Wherever oil is refined—here in America and in the far places of the world—oil men recognize the McKee name as a symbol of engineering integrity.

Refiners know McKee as a source of sound, practical engineering that comes only from long experience and thorough, up-to-date knowledge. They know the conservative business methods which have always characterized this company's activities. They know McKee as an organization with the scope and resources to undertake any refinery project, large or small, and carry it through to completion with efficiency and integrity.

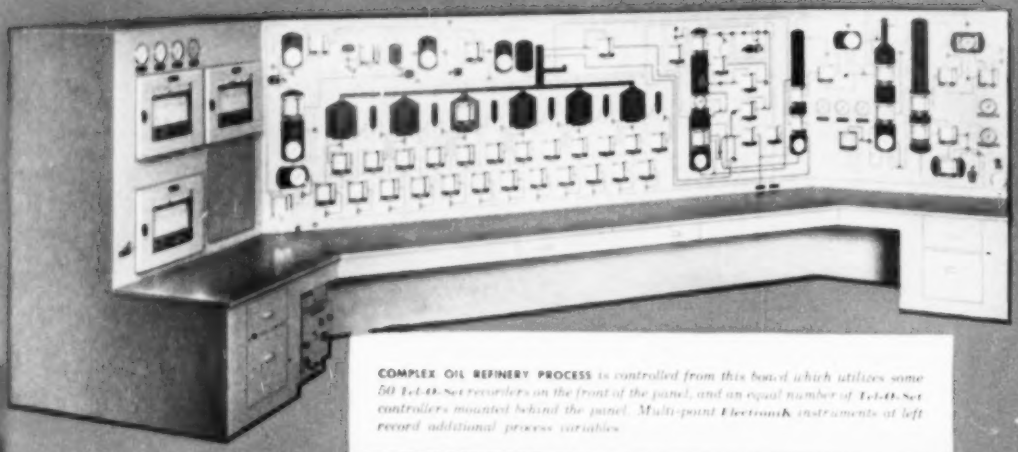
That's why so many refiners use McKee design, engineering and construction services again and again.

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

McKee Engineering

Arthur G. McKee & Company • Established 1905

Headquarters: McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio. *New York Office:* 30 Rockefeller Plaza, New York 20, N.Y. • *Washington Office:* 1507 M Street, N. W. Washington, D. C. • *England:* The Iron and Steel Division of Arthur G. McKee & Company is represented by Head, Wrightson & Company, Ltd. *District Engineering Offices:* Union, New Jersey and Tulsa, Oklahoma.

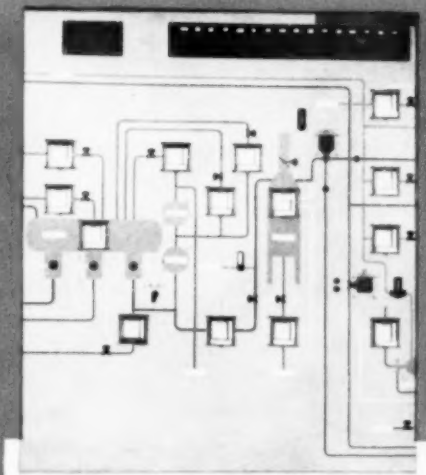


COMPLEX OIL REFINERY PROCESS *is controlled from this board which utilizes some 50 Tel-O-Set recorders on the front of the panel, and an equal number of Tel-O-Set controllers mounted behind the panel. Multi-point Electronik instruments at left record additional process variables.*

Graphic Panels for Centralized Instrumentation...

These well-known companies are taking advantage of Honeywell's specialized knowledge in the design, construction and operation of graphic panels:

Bechtel Corporation
C. F. Braun
Canadian Oil Refineries
Catalytic Construction Co.
Cooperative Refinery Association
Day & Zimmerman Inc.
Derby Oil Co.
Farmers Union Central Exchange Refinery Inc.
The Fluor Corporation Ltd.
Foster-Wheeler Corp.
Great Lakes Refinery
Imperial Oil of Canada
Inter-Mountain Chemical
International Refineries, Inc.
Kanotex Refining Co.
The Lummus Company
Northwestern Refinery
Pan-Am Southern
Phillips Petroleum Co.
The Refinery Engineering Co.
Rohm and Haas Co.
Shell Oil Co.
Sinclair Refining Co.
Socony-Vacuum Oil Co.
Southwestern Engineering Co.
Standard Oil Co. of California
Standard Oil Co. of Indiana
Standard Oil Co. of New Jersey
Sunray Oil Corp.
Sutherland Refiner Corp.
Union Oil Co. of California
Vickers Petroleum



FUNCTION-DESIGNED CONTROL *for a large refinery includes this section in a large graphic panel by Honeywell—using front-of-panel Liquid Level Indicators and Tel-O-Set recorders, plus Tel-O-Set controllers behind the panel.*

PANEL PRODUCTION *in Honeywell's extensive shop, devoted exclusively to panel work—utilizes the skills of highly trained specialists. All instruments, controllers, accessories, and back of panel wiring and piping are carefully assembled—then subjected to rigorous tests to assure trouble-free installation and start-up when the panel reaches your plant.*

. . . a progress report from Honeywell

SHOWN at the left are just two of the many graphic instrument panels which Honeywell has supplied for centralized control of a wide variety of industrial processes. Each one is the result of well-seasoned engineering know-how . . . based on extensive Honeywell experience . . . which combines all instruments and accessories into a closely integrated, efficient design.

Whether your process calls for a full graphic or semi-graphic panel . . . a conventional board . . . or a control cubicle . . . you can be sure of obtaining every feature of quality and performance that you need in a Honeywell panel.

In Honeywell's Panel Division, meticulous attention to engineering detail and highly developed construction techniques watch over every step—from blueprint to assembly to final test. Add to this engineering and manufacturing skill the availability of a complete line of conventional and miniature instruments, and the result is a control board . . . custom-fitted to your needs . . . that makes *Panels by Honeywell* synonymous with the best in centralized control.

Our local engineering representative will be glad to discuss how graphic panels by Honeywell can bring new efficiency to your processes. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4582 Wayne Avenue, Philadelphia 44, Penna.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

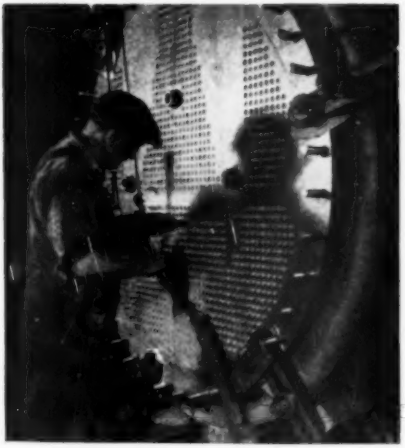
● *Important Reference Data*

First in Controls

Write for your copy of Bulletin No. 85-20, "Centralized Instrumentation . . . unlimited."

FACT

ABOUT TUBE FABRICATION



In addition to saving up to 80 per cent in material costs, Alcoa Aluminum Heat Exchanger Tubes make further savings in fabrication. Their ductility makes them easy to roll in and bead. Completed bundles weigh considerably less than bundles made of heavy metal tubes. This lighter weight is favorably reflected in lower shipping and handling costs.

ALCOA

knows most about their use and application

Alcoa pioneered the use of aluminum in heat exchanger tubes 43 years ago. For complete information on their application and installation, write for a copy of the booklet, *Alcoa Aluminum Heat Exchanger Tubes.* Write:

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OVER 6-MILLION FEET OF ALCOA TUBES ARE IN USE FOR APPLICATIONS LIKE THESE . . .

PETROLEUM

- Condensers handling hydrocarbon fractions from such processes as Thermal and Catalytic cracking, reforming, polymerizing, etc.
- Vapor recovery condensers
- Lube oil coolers
- Natural gas compressor after-coolers
- Recompressor after-coolers
- Hydrogen sulfide gas coolers
- Furfural condensers and heat exchangers
- Propane chilling
- Wax sweaters
- Lean oil - rich oil exchangers
- Amine solution coolers
- Glycol-amine heat exchangers and reboilers

CHEMICAL

- Butanol
- Ethanol
- Ethylene Glycol
- Glycerin
- Hydroabietyl
- Isopropanol
- Methanol
- Phenol
- Propylene Glycol
- Acetaldehyde
- Formaldehyde
- Furfural
- Heptaldehyde
- Acetic acid
- Stearic, Palmitic, Maleic, Oleic acids
- Butyric acid
- Naphtha
- Ricinoleic acid
- Acetanilide
- Ammonia
- Hydrogen Cyanide
- Nitric acid (concentrated)
- Pyridine
- Hydrogen Sulfide
- Benzene
- Dichlorobenzene
- Gelatin
- Hydrogen Peroxide
- Turpentine
- Xylene

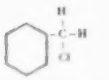
Use Alcoa Alclad 3S-H14 Heat Exchanger Tubes with fresh, brackish and salt-cooling waters

Hooker Chemical Guide
(ONE OF A SERIES)

USE this handy reference to save time in selecting high quality chemicals.

HOOKER TOLUENE DERIVATIVES

BENZYL CHLORIDE



Synonym: Alphachlorotoluene
Formula: $C_6H_5CH_2Cl$
Appearance: Clear, colorless to light yellow liquid.

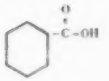
TYPICAL PROPERTIES

Molecular Weight	126.5
Freezing Point	−43° C
Distillation Range (Refined) 5° or less incl.	179.4° C
Distillation Range (Tech.) ... 6° to 10° incl.	179.4° C
Specific Gravity (Refined), 15.5°/15.5° C	1.107
Specific Gravity (Tech.), 15.5°/15.5° C	1.106

USES

Intermediate: Chemicals, dyestuffs, rubber accelerators, gasoline gum inhibitors, perfume bases, plasticizers, resins, wetting agents, pharmaceuticals.

BENZOIC ACID



Synonym: Phenylformic Acid
Formula: C_6H_5COOH
Appearance: White, odorless, crystalline solid. USP grade in powdered form; Technical grade in powdered or bead form.

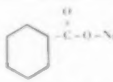
TYPICAL PROPERTIES, USP GRADE

Molecular Weight	122.1
Melting Point	122.0° C
Benzoic Acid	99.3% Min.
Water	0.2% Max.

USES

Intermediate: Dyes, pharmaceuticals, perfumes.
Textile: Dyeing assistant, dye stripping agent, preservative for sizing.
Preservative: Foods, cosmetic creams, lotions, tobacco.

SODIUM BENZOATE



Synonym: Benzoate of Soda
Formula: C_6H_5COONa
Appearance: White, odorless, crystalline solid in flake or powdered form. Available in USP or Technical grades.

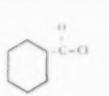
TYPICAL PROPERTIES, USP GRADE

Molecular Weight	144.1
Sodium Benzoate	99 + %
Benzoic Acid	0.2% Max.
Water	0.5% Max.

USES

Preservative: For foods such as tomatoes, fruit juices, syrups, margarine; also preservative for pharmaceutical and cosmetic preparations, tooth paste.
Corrosion Inhibitor: For glycol anti-freeze solutions, chlorinated solvent type metal cleaners, etc.
Chemical Intermediate: Dyestuffs and pharmaceuticals.

BENZOYL CHLORIDE



Formula: C_6H_5COCl
Appearance: Clear, colorless liquid.

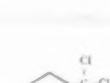
TYPICAL PROPERTIES

Molecular Weight	140.5
Freezing Point	−0.9° C
Boiling Point	198° C
Specific Gravity, 15.5°/15.5° C	1.219

USES

Chemical Intermediate: Introduce benzoyl group into organic compounds.
End Products: Benzoyl peroxide, benzophenone and benzyl benzoate.
Derivatives: Include polymerization catalysts, bleaching agents, perfumes, dyes and pharmaceuticals.

BENZOTRICHLORIDE



Synonyms: Alphatrichlorotoluene
Phenyl Chloroform
Formula: $C_6H_5CCl_3$
Appearance: Clear, colorless liquid.

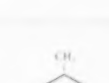
TYPICAL PROPERTIES

Molecular Weight	195.5
Freezing Point	−5° C
Distillation Range	219° to 223° C
Specific Gravity, 15.5°/15.5° C	1.380

USES

Intermediate: Chemicals and dyestuffs.

MONOCHLOROTOLUENE



Synonym: Methylchlorobenzene
Formula: $CH_3C_6H_4Cl$
Appearance: Clear, colorless to straw colored liquid.

TYPICAL PROPERTIES

Molecular Weight	126.5
Freezing Point	below −45° C
Distillation Range	158.3° to 161.7° C
Specific Gravity, 15.5°/15.5° C	1.080

USES

Solvent: Rubber and synthetic resins.
Intermediate: Manufacture of rubber accelerators, chemicals.

For more information on items listed, drop a note on your letterhead to HOOKER ELECTROCHEMICAL COMPANY, 4713 Buffalo Avenue, Niagara Falls, N. Y.

HOOKER ELECTROCHEMICAL COMPANY

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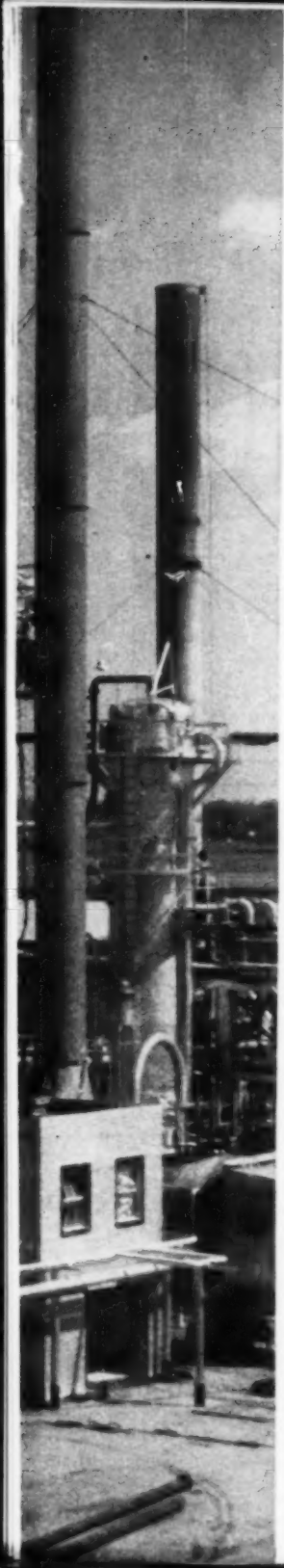
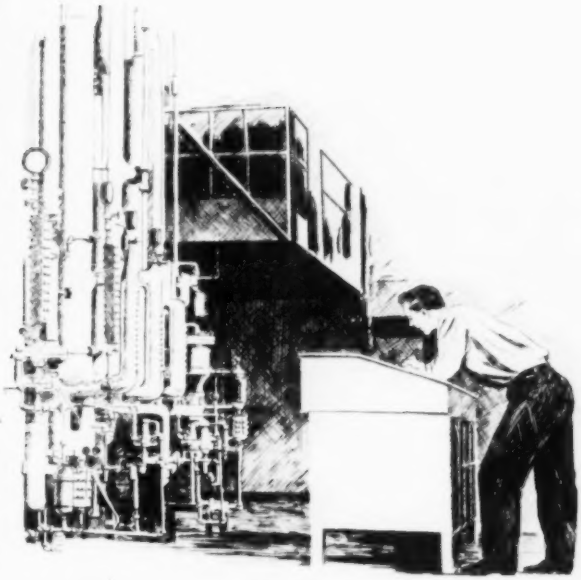
HOOKER® CHEMICALS

2-558

From the Salt of the Earth

DID YOU KNOW THAT
UNIVERSAL SERVICE PROTECTS
YOUR INVESTMENT 7 WAYS?





PILOT PLANT STUDIES PROTECT YOUR INVESTMENT

The science of translating ideas into practical refining processes is a phase of Universal Service that has enhanced the economics of the petroleum industry. Through pilot plant studies, Universal not only determines the commercial worth of new processes but also evaluates charge stocks from fields all over the world. These continuing studies have contributed to the advancement of methods and the improvement of products from petroleum.

Critical analyses of pilot plant tests enable Universal technologists to provide the process most adaptable to the charge stock involved . . . to assemble design data . . . and to provide accurate advance information on the costs of plant construction and operation — another way in which Universal Service Protects Your Investment.

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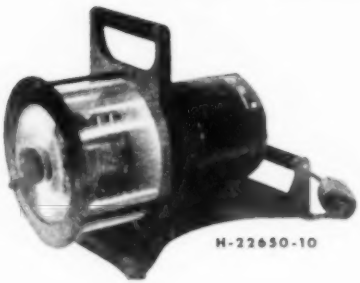
NEW

MERCURY OXIFIER AND GOLD ADHESION FILTER

for thorough mercury cleaning

H-22630



H-22630-10

H-22631-10

H-22651

PRINCIPLE OF THE OXIFIERS

The Oxifier acts in two ways to oxidize base metals. Paddles, developed for the work and driven by motor, (1) produce a copious spray and subject the resulting fine mercury droplets to repeated contact with air; and (2) break up oxide skins, and carry them under and through the mercury mass until oxidation is complete. After this treatment nothing oxidizable remains in the mercury.

PRINCIPLE OF THE GOLD-ADHESION FILTERS

Action of the Filter is not that of straining through small holes—the usual understanding of "filtering"—but the principle of decanting. All foreign substances—the oxidized precipitates formed by the Oxifier, water, oil, etc.—float on mercury, leaving the central body clean. The filter draws from this clean central body and decants through a large aperture in the bottom.

Mercury does not "wet" the sides of a container, and contaminants work down between mercury and sides and would flow through the bottom aperture, except for the gold seal. This is a ring of gold alloy surrounding the aperture, and since gold is wet by mercury the adhesion between the two elements forms a positive seal through which contaminants cannot pass. Exacting tests show this gold-adhesion principle to be completely effective; removal of impurities is not partial as with chamois skin, seepage through porous members, etc. Mercury emerges in a bright, lively stream, bone-dry and entirely free of acid or oil film.

GENERAL LABORATORY SET

H-22630—25-lb. Oxifier—Cleans 100 lbs. a day in 25-lb. batches. Oxidizes dissolved base metals. Height 17½", table space 16" x 10", weight 63 lbs.; Motor 1/12 HP, 115 V, 60 Cy. A.C.; V-belt drive; switch on motor. All exposed parts finished in green and black enamel. Complete, ready to run. Each **$180.00**

H-22651—Type "F" Filter—Eliminates floating impurities; water, oil, oxide-dust, but NOT dissolved metals. Height 17", table space 7" x 7", weight 5¼ lbs.; Plastic acid-resistant reservoir holds 25 lbs.; filters in six minutes. Provided with shut-off valve. Cast iron frame finished in green and black enamel; other parts stainless steel. Each **$50.00**

SMALL SET

H-22630-10—5-lb. Oxifier—Cleans 20 lbs. a day in 5-lb. batches. Oxidizes dissolved base metals. Height 7", table space 9" x 5", weight 8 lbs.; Motor, direct-connected 1/70 HP, 115 V, 60 Cy. A.C., with line switch. Cast iron frame, finished in green and black enamel. Each **$77.50**

H-22651-10—Type "G" Filter—Eliminates floating impurities; water, oil, oxide-dust, but NOT dissolved metals. Height 6½", table space 3½" dia.; weight 1 lb., 2 oz.; No reservoir or shut-off valve; mercury can be poured through at rate of 5 lbs. in two minutes. Plastic and stainless steel. Each **$20.00**

HARSHAW SCIENTIFIC
DIVISION OF THE HARSHAW CHEMICAL CO.
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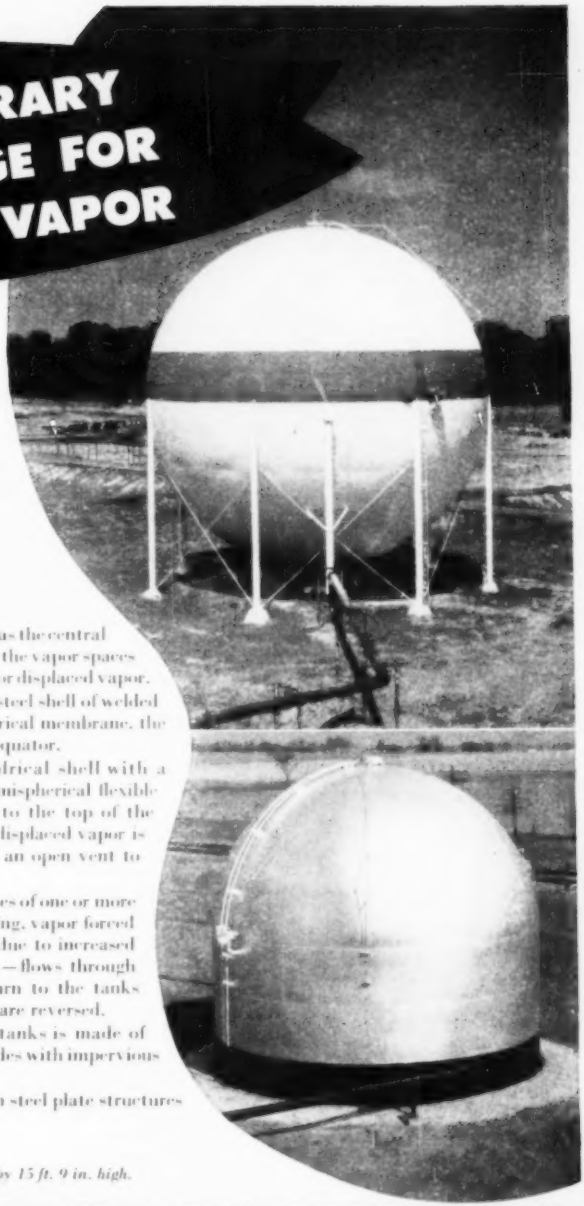
(To obtain more data on advertised products see page 1680)

TEMPORARY STORAGE FOR DISPLACED VAPOR

with HORTON VAPORSPHERES and VAPORTANKS



A Horton Vapor-sphere* or Vaportank* can be used as the central storage unit for a vapor saving system. Connected to the vapor spaces of fixed-roof tanks, they provide temporary storage for displaced vapor.

The Horton Vapor-sphere consists of a spherical steel shell of welded construction. Inside the shell is a flexible hemispherical membrane, the outer edge of which is connected to the shell at its equator.

The Horton Vaportank consists of a cylindrical shell with a hemispherical top and flat bottom. Inside is a hemispherical flexible membrane, the outer edge of which is attached to the top of the straight portion of the tank shell. In both tanks, displaced vapor is stored under the membrane. The space above has an open vent to allow air to flow in and out.

When either tank is connected to the vapor spaces of one or more fixed-roof tanks by light weight, large-diameter piping, vapor forced out of the fixed-roof tanks—either by breathing due to increased temperature or by displacement caused by filling—flows through the lines into the storage unit. These vapors return to the tanks when conditions which caused their displacement are reversed.

The membrane used in these vapor saving tanks is made of Chi-lon*, a tough, durable fabric, coated on both sides with impervious petroleum-resistant synthetic rubber.

Complete details or quotations on these Horton steel plate structures may be obtained by writing our nearest office.

Above: 100,000-cu. ft. Horton Vapor-sphere 58 ft. in diam.

Right: 25,000-cu. ft. Horton Vaportank 36 ft. 6 in. in diam. by 15 ft. 9 in. high.

**Trade Mark Registered U. S. Patent Office*

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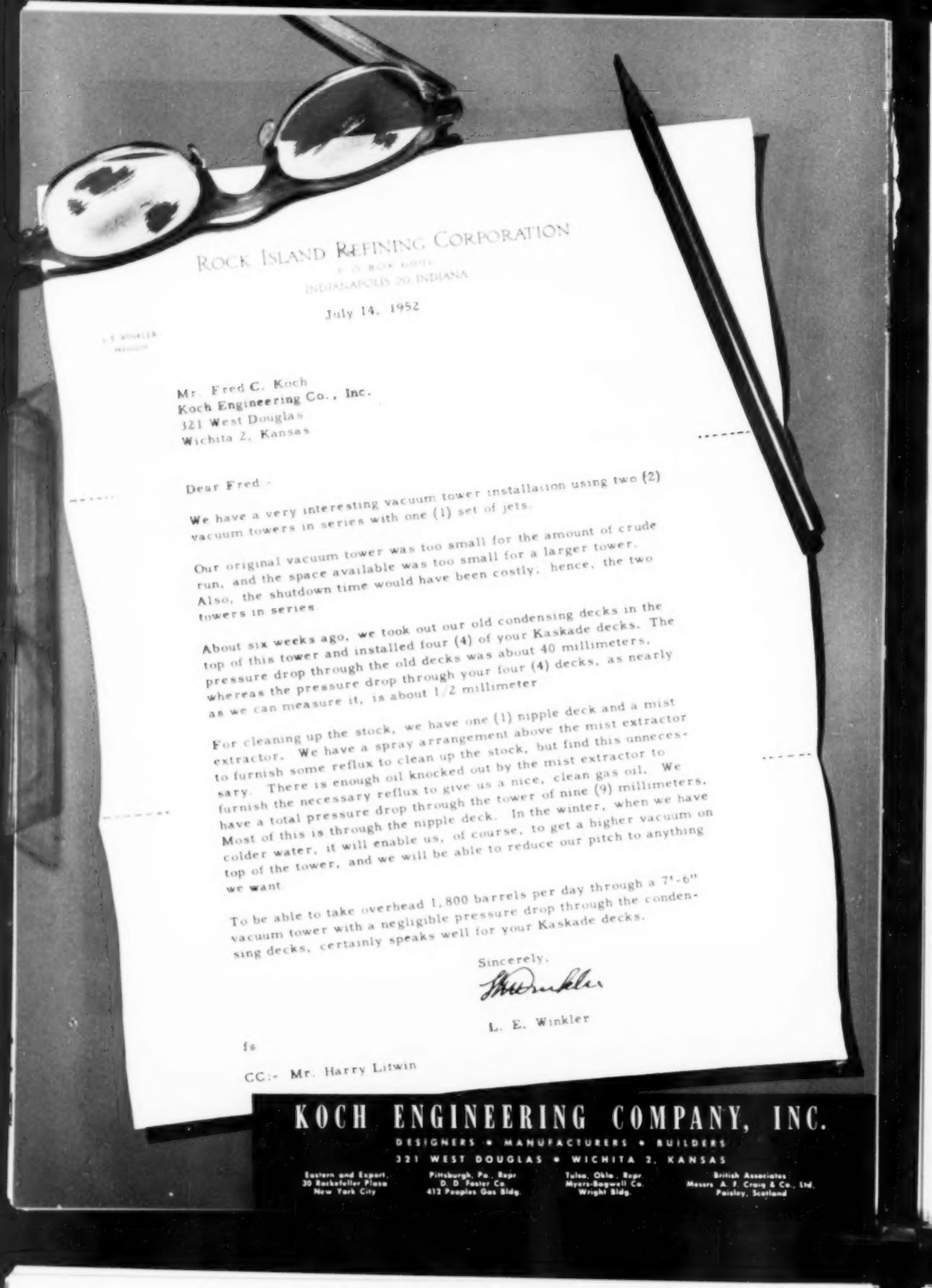

ROCK ISLAND REFINING CORPORATION

P. O. BOX 40011

INDIANAPOLIS 20, INDIANA

July 14, 1952

L. E. WINKLER
PRESIDENT

Mr. Fred C. Koch
Koch Engineering Co., Inc.
321 West Douglas
Wichita 2, Kansas

Dear Fred -

We have a very interesting vacuum tower installation using two (2) vacuum towers in series with one (1) set of jets.

Our original vacuum tower was too small for the amount of crude run, and the space available was too small for a larger tower. Also, the shutdown time would have been costly; hence, the two towers in series.

About six weeks ago, we took out our old condensing decks in the top of this tower and installed four (4) of your Kaskade decks. The pressure drop through the old decks was about 40 millimeters, whereas the pressure drop through your four (4) decks, as nearly as we can measure it, is about 1/2 millimeter.

For cleaning up the stock, we have one (1) nipple deck and a mist extractor. We have a spray arrangement above the mist extractor to furnish some reflux to clean up the stock, but find this unnecessary. There is enough oil knocked out by the mist extractor to furnish the necessary reflux to give us a nice, clean gas oil. We have a total pressure drop through the tower of nine (9) millimeters. Most of this is through the nipple deck. In the winter, when we have colder water, it will enable us, of course, to get a higher vacuum on top of the tower, and we will be able to reduce our pitch to anything we want.

To be able to take overhead 1,800 barrels per day through a 7'-6" vacuum tower with a negligible pressure drop through the condensing decks, certainly speaks well for your Kaskade decks.

Sincerely,

L. E. Winkler

fs

CC:- Mr. Harry Litwin

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Here at Lummus we hold a deep respect for our customers' 1952 dollar and 1957 returns. *This* has a meaning all its own to responsible management with capital to commit for petroleum, petroleum chemical and chemical plants.

You'll find these price-and-value factors well taken care of in every project designed, engineered and constructed by Lummus. On each job, *process improvement* is the paramount goal—achieved by applying every technological advancement and modern design. This we won't compromise, no matter how great the demand may be for immediate new production facilities.

What's more, the plants must have the flexibility to answer needs of the future. Engineering ingenuity at Lummus concerns itself with taking every precaution today against a future time when outmoded tools may put you at a competitive disadvantage.

That sums up our interpretation of judicious spending. Over six hundred soundly-designed, profit-producing plants have been built on this steadfast concept. You may wish to bear these facts in mind on *your* next project.

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Read what they say about Lectrodryers* in England

where this picture was taken

These Lectrodryers DRY hydrocarbons processed here.

"High pressure Lectrodryer equipment has proved an ideal solution to this difficulty in refineries . . . it removes water vapour content of petroleum gases and prevents formation of undesirable hydrates. It prevents formation of ice."

From all over the world, from every industry, come similar reports on Lectrodryer performance. They DRY air, gases and organic liquids to low dewpoints, keeping delicate reactions on the straight and narrow path. They help boost output and product quality by assuring maximum production and avoiding unwanted side reactions.

Whether you're planning a pilot plant or going into production, there's a Lectrodryer to suit your every DRYing requirement. For help in selecting the drier you need, write Pittsburgh Lectrodryer Corporation, 332 32nd Street, Pittsburgh 30, Penna.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
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DU PONT

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT

November ★ One of a Series of Interest to the Petroleum Industry ★ 1952

YOUR CUSTOMERS...Have you recently reminded them of these rules for good driving?

1. Avoid high speeds. Drive at a reasonable speed that will get you there on time.
2. Drive the road ahead. Watch traffic and lights. Pace driving to make as few stops as possible.
3. Make slow, easy starts. Shift to high as soon as possible.
4. Under normal driving conditions, don't press the accelerator to the floor.
5. Avoid sudden stops.
6. Adjust seat so legs are comfortable for a light steady pressure on the accelerator. Don't pump the pedal!
7. On open stretches maintain a constant speed.
8. On up-grades don't attempt to maintain constant speed.
9. Be sure tires are inflated to proper pressure.
10. Use the proper grade lubricants for anticipated seasonal weather conditions.

Complete Manual on Gasoline Dyes Soon Available

New booklet on Du Pont Gasoline Dyes contains all the information a refiner needs to know about dyeing gasoline.

Ever since tetraethyl lead was first used as an antiknock compound, coloring has been an important factor in making gasoline.

Gasoline dyes, however, have for a long time presented a number of han-

dling problems. And it was not until recently that efficient methods of addition were worked out.

All of the latest methods of dyeing gasoline are fully discussed in a new booklet, "Du Pont Gasoline Dyes." It covers the dry dye eductor system as well as the various other methods of addition by dye pot.

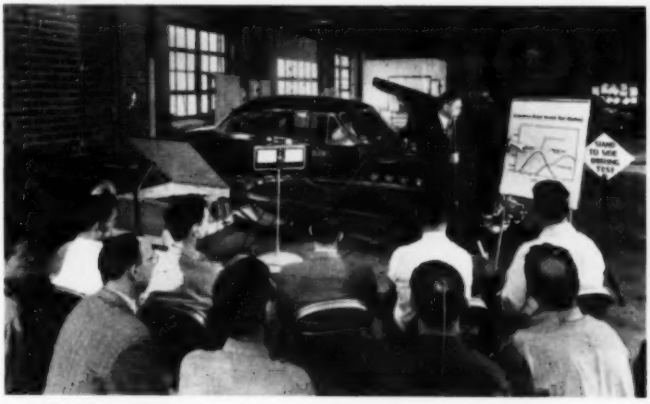
The booklet also gives complete information – including solubility charts and spectrophotometer curves – on all the Du Pont gasoline dyes. And it contains full data on meeting color requirements for military, aviation and leaded motor gasoline.

In addition, the booklet includes much helpful information on handling dyes, such as how to remove dye stains from clothing and equipment – and useful shipping information.

This booklet will soon be available to refiners through the Du Pont Petroleum Chemicals Division district offices.

New Dynamometers Broaden Usefulness to Refiners of Du Pont Test Car Fleet

When a car engine knocks, the cause may be from a variety of factors other than gasoline quality. This fact is readily demonstrated to fleet owners or other groups by the new Petroleum Chemicals Division traveling dynamometers which are part of Du Pont's fleet of 53 road octane test cars.



ROBERTS W. BROKAW, JR., Du Pont representative, uses the Du Pont test car and dynamometer combination for demonstrating road knock by the Uniontown method.

Suppose you want to show a customer group the effect of speed, spark advance, air-fuel ratio, operating temperature, and altitude as well as fuel quality on engine performance and octane requirement. The dynamometer and Du Pont test car combination is all that is needed to make a convincing demonstration.

ANSWERING QUALITY COMPLAINTS

Suppose, on the other hand, you want to refute quality complaints with a dash of real showmanship. The dynamometers can be employed to point up the effect of poor operating maintenance on engine performance . . . by simulating faulty ignition, fouled spark plugs, over-advanced spark timing and improper carburetor adjustment.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Dynamometers*

These versatile dynamometers are each equipped with a speedometer, road power meter, fuel flow meter, air-fuel analyzer, intake vacuum gauge and various temperature indicators. An easel and a public address system together with special microphones to amplify the speakers voice all help make the demonstration clear and understandable.

FLEXIBLE PROGRAM

Du Pont automotive specialists have been trained in putting on dynamometer demonstrations. A wide choice of program material is offered and can be readily tailored to meet the specific needs of an individual oil company.

The length of time required for a demonstration is completely flexible . . . ranging from one hour to a full afternoon. And the equipment can be set up outdoors or in any large room or building having adequate ventilation.

Refiners and marketers who are interested in learning about this new sales promotion tool should get in touch with the nearest Du Pont Petroleum Chemicals Division district office for details.

Copper Picked Up By Gasoline in Pipeline

It is often difficult to trace the exact source of contamination when copper is found in gasoline. Therefore, the following case history of copper picked up by gasoline during pipeline transfer is of interest.

A new products pipeline was recently put into operation by an oil company. Gasoline entering this pipeline with an induction period of 14 hours was found to leave the pipeline 416 miles away with an induction period of 5 hours.

To determine the source of contamination, the copper content of the gasoline was checked at various points along the pipeline. It was found to be building up in proportion to the miles traveled through the line, from 10ppm initially to 22ppm at the destination.

Further investigation showed that engines at the pump stations along the pipeline were being cooled by copper heat exchangers. And it was discovered that gasoline circulating around the copper coils, which carried water at approximately 150° F., was picking up sufficient copper to cause the difficulty. The pump impellers, which were fabricated of an alloy containing copper, were also contributing to the trouble.

At this stage Du Pont Metal Deactivator was used to counteract the copper contamination. It was found that only ⅞ lb. of the deactivator per 1,000 barrels of gasoline, added at the pipeline exit, was needed to restore the original 14-hour induction period.

Normally it would be recommended to add Metal Deactivator to gasoline *at the refinery*, before it entered the distribution system.

Bernard Miller Sturgis

Bernard M. Sturgis is head of the Combustion and Scavenging Research Division of the Du Pont Petroleum Laboratory. He is in charge of fundamental research on combustion problems and on the problems associated with deposits in engines, as well as the development of and evaluation of new additives in these fields.

Sturgis joined Du Pont in 1936 after having won a 4-year Thomas A. Edison scholarship which helped him toward obtaining his Ph.D. degree in chemistry at M.I.T.

Among various duties at Du Pont's Jackson Laboratory, he did fundamental research on vulcanization and on the properties of stretched rubber. Later he was made group leader in charge of all research on chemicals for natural and synthetic rubber and on polymerizable monomers. During this time he obtained 27 patents and published several papers in this field.

Before being transferred to the Petroleum Laboratory in 1951, he was head of the Petroleum Chemicals Division of Jackson Laboratory in charge of research on tetraethyl lead, combustion and petroleum additives.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets and aids available to you through your Du Pont Petroleum Chemicals Division district office:

Safety for the Small Refinery — A 42-page book on how to set up an effective small refinery safety program. Serial A-2848

Tank Talk — A 32-page, easy-to-understand safety booklet for tank-cleaning crews. Serial A-1134

Stability of Present-Day Gasolines — A 12-page paper on the value of storage tests—as compared with induction period—for determining stability of modern gasolines. Serial A-3199

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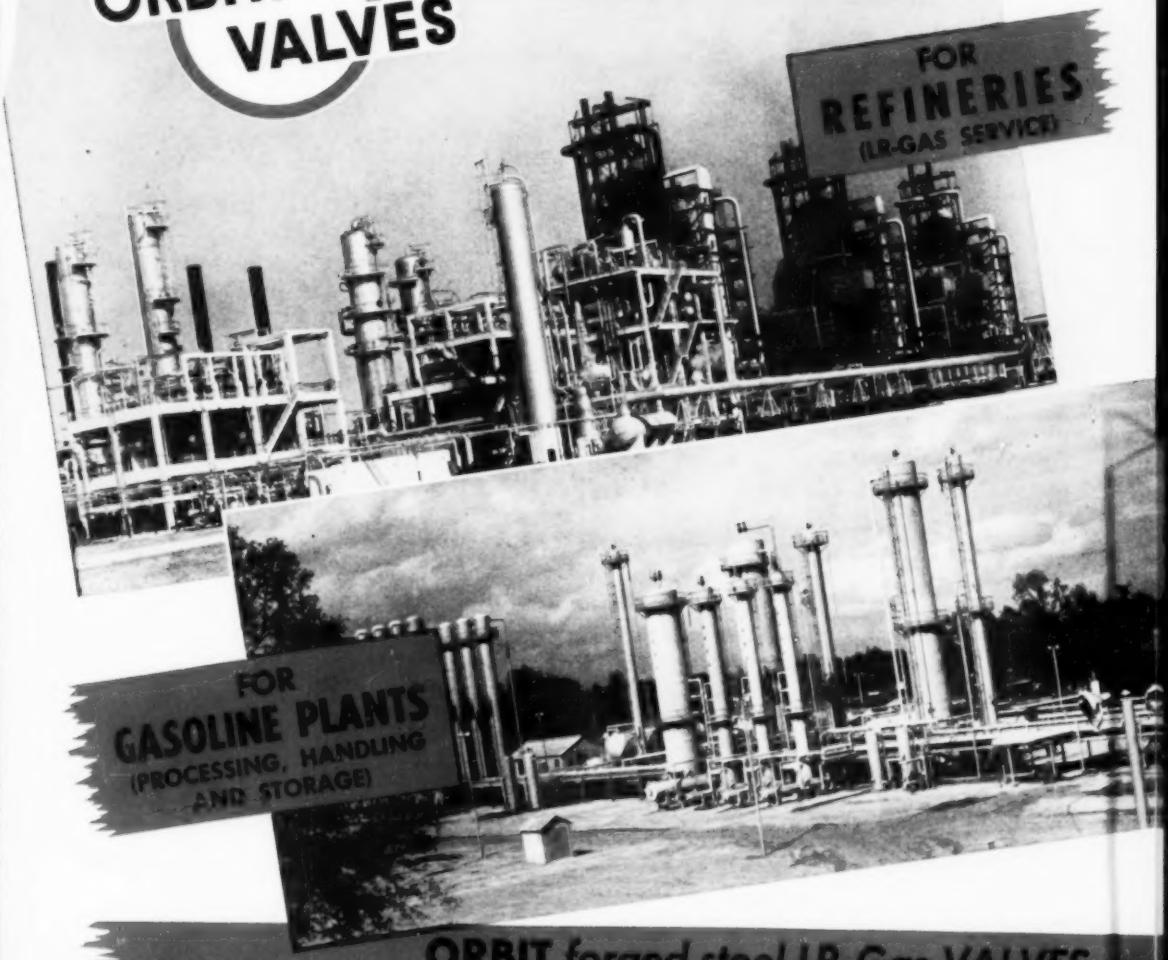

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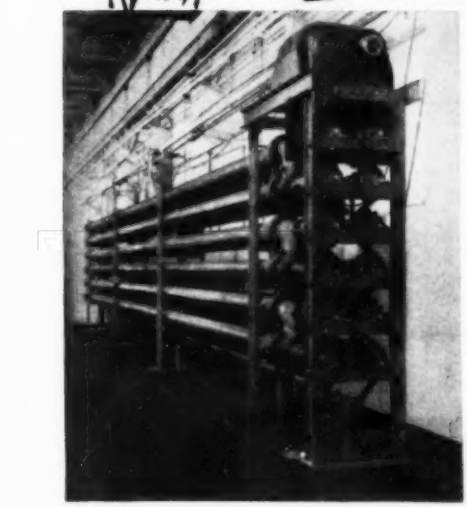
DOUBLE PIPE EQUIPMENT is available in two types; EXCHANGERS, for cooling with water, brine, and cold filtrate, and for heating with steam or hot liquids; and CHILLERS, for use with volatile refrigerants such as ammonia, propane, and Freon. Both types have 8" jacket pipes and 6" inner pipes with scrapers.

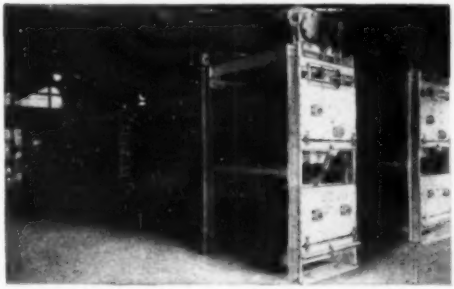
SHELL AND PIPE TYPE UNITS are designed for use with volatile refrigerants and for heating fluids with steam or similar heating mediums. They consist of large welded shells each containing seven 6" scraped pipe sections.

Vogt Scraped Surface Exchangers serve profitably as oil chillers, crystallizers, and heaters in many processes in the petroleum and chemical industries. Their application to your heat transfer problems will receive the prompt attention of our Engineering staff.

Write for Bulletin PE-1



***DOUBLE PIPE UNIT.** Drive end close-up of 12 section unit under test in our shop.*



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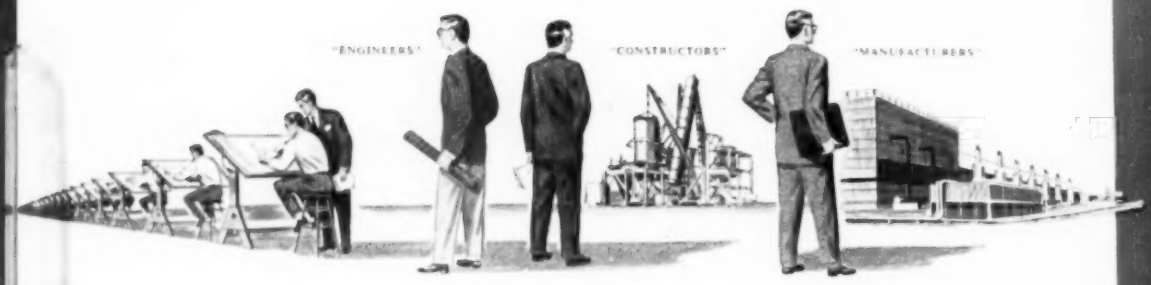
How would **you** define **FLUOR?**



Some say it's an Engineering Firm, others say it's a Construction Company. Still others call Fluor a Manufacturer. Actually Fluor is all three!

Because of the breadth of Fluor's activities since the turn of the century, different people in different industries have identified Fluor as an engineering firm, a construction company, or a manufacturer of cooling and processing equipment. This is understandable.

It is because, where clients have used Fluor's highly specialized services *individually*—engineering, construction *or* manufacturing—satisfaction itself has identified Fluor as an expert in the particular service successfully performed. This can be good. But it can also be limiting to the industries which Fluor serves.

It can be limiting in the sense that the satisfied client of a *single* Fluor service may, through incomplete identification, miss the benefits of Fluor's *complete* service—engineering, construction *and* manufactured products. Whenever you plan new construction or the expansion of old, compare *all* of Fluor's qualifications and services. The abilities to design, engineer and construct complete plants and facilities for the petroleum, chemical and other heavy industries—anywhere in the world—on time and within appropriation, have been proved time and time again.

These facts about Flour give the complete story of what Fluor does—what Fluor has to offer *you*. More detailed information may be obtained from your nearest Fluor representative. He will be pleased to cooperate in any way possible. You can be *sure* with Fluor!

These Facts make Fluor a World Wide Organization

A MANAGEMENT KNOWN FOR ITS EFFICIENT ORGANIZATION
—of Fluor—of your project within Fluor

The ability to organize in the face of constantly changing conditions accounts for Fluor's steady growth into recognition as a major engineering and construction firm. Good organization is demonstrated in the pride and teamwork evident throughout Fluor—in the handling of client's projects within Fluor. Each project has its own unit job organization under *one* project manager. He draws upon the many technical groups which make up Fluor and is responsible for your project—from beginning to completion.

A RESEARCH AND DEVELOPMENT DIVISION
for the study of problems—the development of ideas

Fluor's Research and Development Division is staffed with technically educated and thoroughly experienced chemical engineers, chemists, physicists, and mechanical engineers, specializing in fundamentals and problems relating to the gas and petroleum processing industries and phases of the petrochemical and chemical industries. These personnel and facilities are available at all times to Fluor's engineering groups for the study of unusual problems and development of new ideas.

A PURCHASING GROUP—AN ACCOUNTING GROUP—
wide in scope—flexible in operation.

These two highly specialized departments play a vital role in the successful and satisfactory completion of Fluor projects. They are geared to coordinate both inter-departmentally and with the established procedures of customer and vendor companies. Their services include the purchasing, inspection and expediting of materials and equipment for job sites anywhere in the world, and the establishment of efficient accounting systems according to individual client requirements. Broad experience is evidenced—material and equipment is being currently purchased at the rate of over $5,000,000 a month!

A LARGE RESERVOIR OF ENGINEERING TALENTS—
with broad, diversified experience—modern facilities

Fluor's Engineering Division is permanently staffed with over 800 chemical, process, mechanical, electrical, instrument, civil, architectural and hydraulic engineers and draftsmen. Headquartered in Los Angeles and Houston in modern buildings designed specifically for the expeditious handling of a large variety of engineering services, the broad and diversified experience of these groups embraces all types of projects—from the smallest unit to the largest—in natural gas, petroleum, petrochemical and industrial fields.

AN EXPERIENCED CONSTRUCTION ORGANIZATION—
skilled in all crafts—world-wide in reputation

Working in parallel and complementing the skills of Fluor's engineering groups, the Construction Division is permanently staffed with over 250 key men who are experienced in the construction of plants and facilities both in and out of the continental United States. This policy assures the availability of competent men for every project and enables Fluor to retain a closely knit organization which may be expanded around a nucleus built up over a period of years. The soundness of the policy is evident in the high degree of loyalty of these men to the interests of both Fluor and its clients.

A MANUFACTURED PRODUCTS DIVISION—
an independent division—complete within itself

Fluor's Manufactured Products Division is a large, completely integrated organization devoted exclusively to the design, development and manufacture of natural draft and induced draft cooling towers, air-cooled heat exchangers, pulsation dampeners, mufflers, gas cleaners, and other special products. This division functions independently, with modern facilities strategically located on the West Coast and in the center of the United States. The highly specialized products manufactured by this division are recognized throughout the world for sound engineering, quality construction and guaranteed performance.

STRATEGICALLY LOCATED SALES AND SERVICE OFFICES—
close client contact—the ability to serve

Fluor's Sales and Service offices are so located and so staffed that continuing sales and technical contact can be maintained to meet customer requirements anywhere in the world. Fluor representatives are technical men with technical experience. They are qualified to give detailed information—to make decisions. These things are important when evaluating the abilities of a contractor to successfully perform difficult and complex projects involving engineering, construction and/or the supplying of special products.

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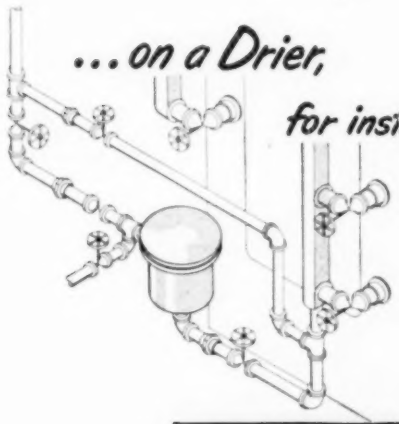
Example of Steam Trap Durability

...on a Drier, for instance



THE INSTALLATION

On heavy-duty, steam-heated tumbler-type drier at American Linen Supply Company, Cincinnati.

THE HISTORY

A high discharge capacity trap was needed to operate this drier 16 hours daily under heavy loads, with 125 psi. steam. Specifications called for rapid, fully automatic condensate removal to insure fast warm-ups and a steady flow of hot, dry steam to the drier. Naturally, the lowest possible trap maintenance cost was also wanted.

The choice was a Crane 150-Pound Inverted Open Float Steam Trap, carefully selected for adequate drainage capacity, and above all, properly installed.

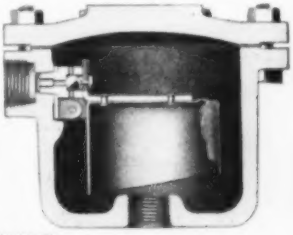
In service more than 8 years and never needing any repairs or new parts, the Crane trap has given complete satisfaction. Total maintenance expense: periodic routine inspection only.

TRAP SERVICE RATINGS

SERVICE LIFE:	More than 8 years - Heavy duty
SUITABILITY:	High discharge capacity
MAINTENANCE COST:	None - Routine inspection only
SPECIAL FEATURES:	Simple, dependable mechanism
OPERATING RESULTS:	Fast warm-ups - Steady even heat
PRICE:	Good Buy
AVAILABILITY:	Stock item in Crane line

THE TRAP

Crane Iron Body Inverted Open Float Steam Trap, for 1 to 300 pounds saturated steam working pressures. Small and compact in all sizes, yet has high discharge capacity. Patented ball-type seating gives positive pressure seal. Simple operating mechanism with only one moving unit assures durable, trouble-free performance. See your Crane Catalog or your Crane Representative for complete data on these highly efficient traps.



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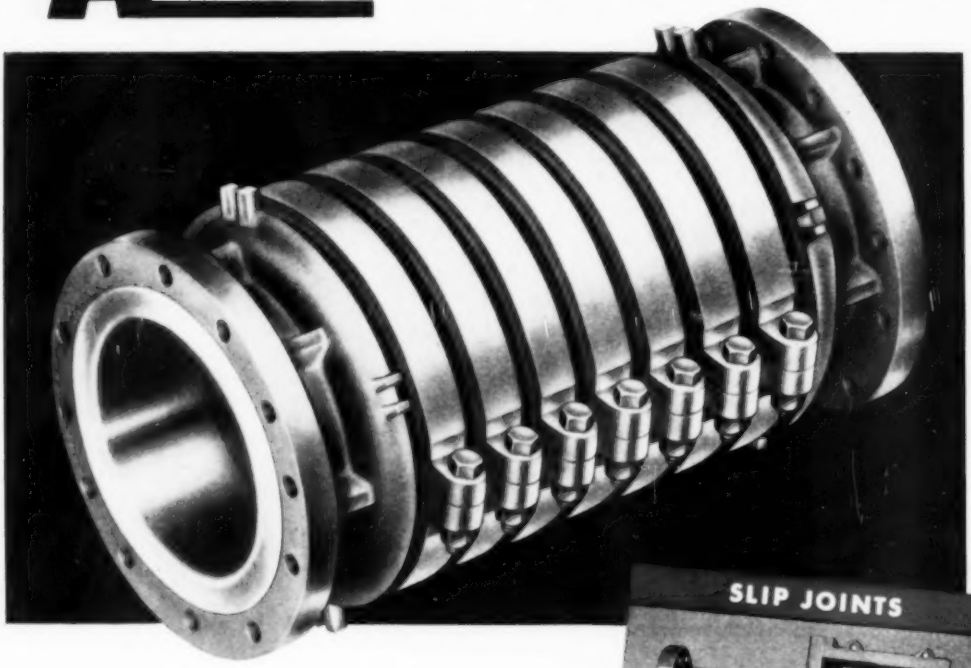
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

ADSCO EXPANSION JOINTS



We don't have to sell what you don't want to buy, because only ADSCO makes a complete line of expansion joints. The modern Corruflex, shown above, is the result of 50 years' experience in packless expansion joints. Equalizing and non-equalizing Corruflex joints cover wide temperature and pressure ranges and are built in many designs, including universal, tie-rod, hinge, and fully-guided. They will solve nearly all pipe-expansion problems caused by temperature differential, whether the material in the pipes is liquid, gas, or steam. Write for Bulletin 35-51.

ADSCO
75 YEARS OF LEADERSHIP

AMERICAN DISTRICT STEAM COMPANY, INC.
NORTH TONAWANDA, NEW YORK

The solvents and chemicals sold under the ENJAY* Oval Trade-Mark are outstanding for high quality and dependability. Every day more industries are calling on the long experience of the Enjay Company . . . making greater use of the diversified line of solvents and chemicals marketed by Enjay to increase product quality.

ENJAY markets this wide range of industrial chemicals:

Petrohol 91 (Isopropyl Alcohol)
Petrohol 95 (Isopropyl Alcohol)
Petrohol 99 (Isopropyl Alcohol)
Secondary Butyl Alcohol
Isooctyl Alcohol
Isopropyl Acetate
Secondary Butyl Acetate
Acetone
Methyl Ethyl Ketone
Ethyl Ether
Isopropyl Ether
Diisobutylene
Polypropylenes
Butadiene
Isoprene
Dicyclopentadiene
Aromatic Tars
Paratone
Parapoid
Paratac
Paranox
Paraflow
Vistanex
Naphthenic Acids

ENJAY products are marketed in bulk or in quantities to fit your requirements.

ENJAY COMPANY, INC.
15 W. 51st St., New York 19, N. Y.

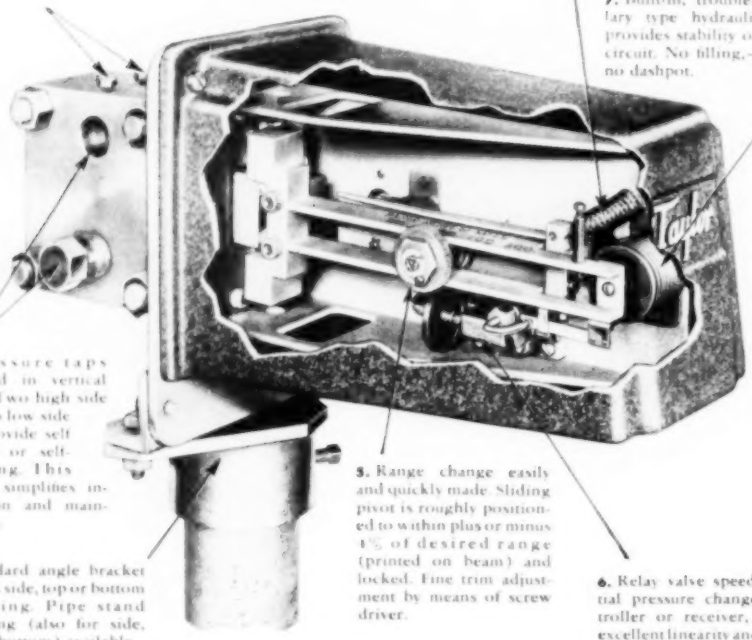
Taylor announces

1. Dry meter operates on force-balance principle. Diaphragm of Teflon coated glass cloth. Body working pressure rating 1500 psi. Available in either forged steel or type 430 stainless steel.

2. Vent screws to provide for total filling in liquid service.

8. Provision for adjustment of range suppression up to 100%.

7. Built-in, trouble-free, capillary type hydraulic damping provides stability of pneumatic circuit. No filling,—no mess—no dashpot.

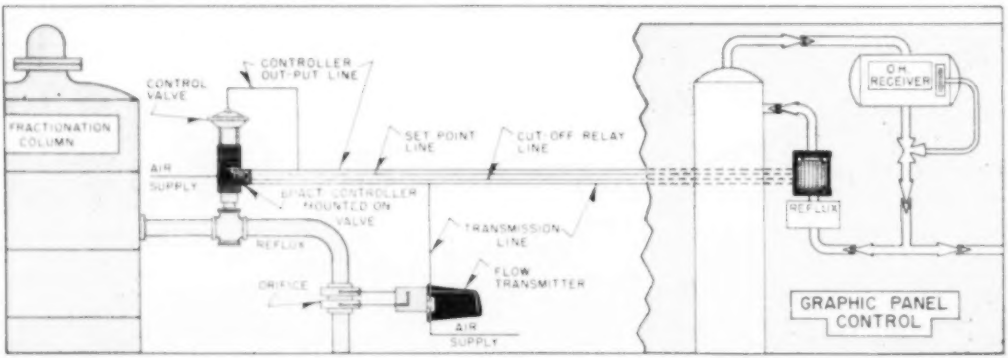


3. Pressure taps mounted in vertical plane. Two high side and two low side taps provide self venting or self-draining. This feature simplifies installation and maintenance.

4. Standard angle bracket permits side, top or bottom mounting. Pipe stand mounting (also for side, top or bottom) available.

5. Range change easily and quickly made. Sliding pivot is roughly positioned to within plus or minus 1% of desired range (printed on beam) and locked. Fine trim adjustment by means of screw driver.

6. Relay valve speeds differential pressure changes to controller or receiver, providing excellent linearity and minimum hysteresis.



SIMPLIFIED FLOW MEASUREMENT

With the NEW Taylor TRANSAIRE® Differential Pressure Transmitter

INEXPENSIVE AND SIMPLE TO INSTALL

1. Simplified piping because it can be close coupled to orifice flanges.
2. No leveling—mercuryless dry meter.
3. Side, top or bottom bracket mounting; available with 2" pipe stand.
4. No seal pots required—negligible displacement because of force balance construction.
5. Light weight for easy handling; weighs only 23 lbs.
6. Vent screws for simple, solid filling.

ECONOMICAL—EASY TO MAINTAIN

7. Self draining or venting—no periodic manual venting or draining.
8. Mercuryless — flexible but tough Teflon coated glass fabric diaphragm.
9. Overrange protection to full body rating.
10. Purges, if required, can be installed to keep body swept clean.
11. Simple range change by sliding pivot—screw driver trim.

ACCURATE

12. Relay valve for linearity, minimum hysteresis, fast speed of response.
13. Pressure effect 0.2% / 100 psi. change.
14. Temperature effect 1.0% / 100°F. change.
15. Self draining and venting. No errors build up during operation.
16. Damped pneumatic circuit—stable air output even on vibrating pipe lines.

RUGGED AND DEPENDABLE

17. Body forged steel or type 430 Stainless Steel. Working pressure rating, 1500 psi.
18. Weather proof housing built for tough service and outdoor mounting.
19. Force balance construction—negligible motion—minimum possible wear.
20. Process sealing bellows 3-ply type 316 stainless steel.

ADAPTABLE

21. 100% suppression—continuously adjustable from 0 to 100%. Ideal for liquid level applications.
22. Ten-to-one rangeability in each of two forms: a. 20-200" water b. 80-800" water.

Find out more about this new flow and liquid level transmitter. Ask your Taylor Field Engineer, or write for **Bulletin 98226.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

puts the HEAT on heat exchangers

By changing to Yarway Impulse Steam Traps, an oil refinery reports much hotter steam in their heat exchangers —**plus two other important extras:**

(1) They were able to operate the plant with 6 boilers instead of the 8 formerly required.

(2) Three men formerly required to service old-type traps can now be used for productive work.

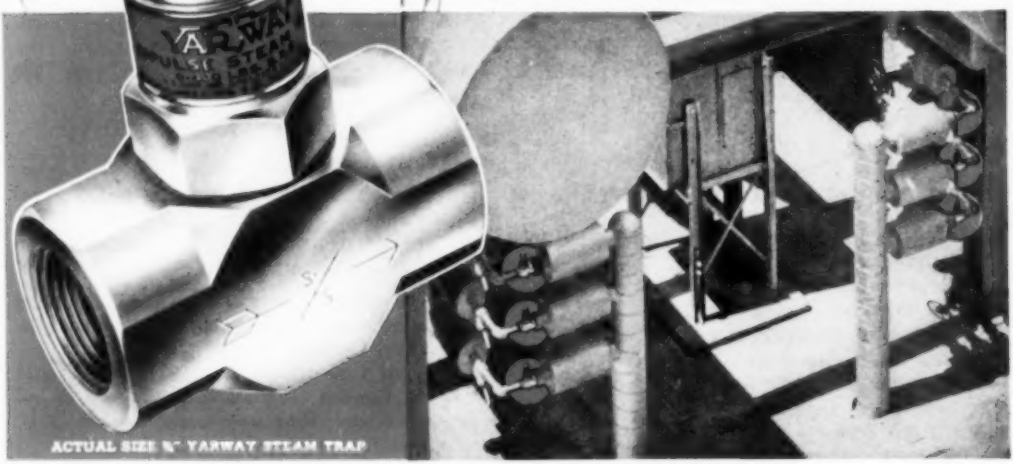
Significant sidelight—these Yarway traps are operating under severe conditions, many outdoors with temperatures often below zero.

Plant after plant is standardizing on Yarway Impulse Steam Traps because Yarways are designed to deliver the most premium B.T.U.'s at top temperatures into your process or product. **They get equipment hotter, sooner . . . and keep it hot.**

Other reasons—small size, easy installation, good for all pressures, only one moving part, low maintenance, low price.

Buy your Yarway Impulse Steam Traps from one of the 216 distributors handling this product.

YARNALL-WARING COMPANY
153 Mermaid Ave., Philadelphia 18, Pa.



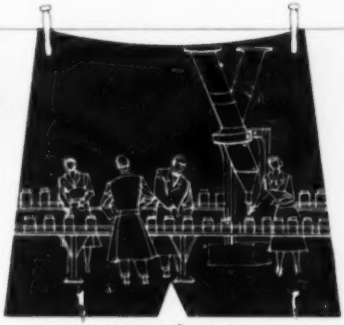
ACTUAL SIZE ¾" YARWAY STEAM TRAP

FREE OFFER. Don't take our word for it. Test Yarway's advantages in your own plant, without cost or obligation. Drop us a card or letter—a trial trap will be delivered promptly.

YARWAY the steam trap
designed with more production in mind

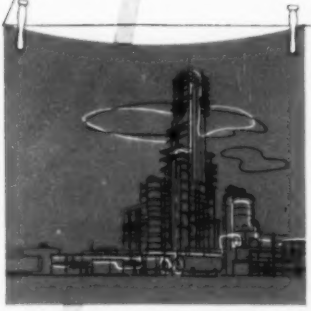
There's no limit

STOREROOMS, dried with Alcoa Activated Alumina, protect raw materials and finished products from moisture deterioration.



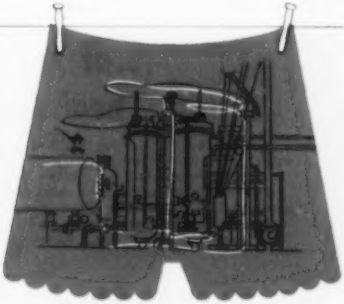
PACKAGING AND PROCESSING ROOMS in food, drug and candy plants are kept at uniform humidities with Alcoa Activated Alumina, to maintain production regardless of the weather.

to what you can dry



INSTRUMENT AIR, dried by Alcoa Activated Alumina, prevents freeze-ups and corrosion of outdoor valves, trips and recorders.

LABORATORIES testing paper, textiles, chemicals require controlled humidity provided by Alcoa Activated Alumina.



PETROLEUM PRODUCTS—liquids, gases or gaseous hydrocarbons—can be dried to minus 100°F dew point—or lower!

with ALCOA Activated Alumina!

ALCOA Activated Alumina is the "old reliable" in the desiccant field. It dries to lower dew points than other commercial adsorbents. It will not swell, soften or disintegrate . . . can be used over and over again almost indefinitely.

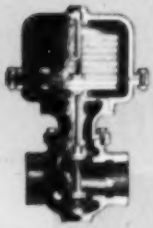
Now *new* and *better* Activated Aluminas are on the way, with improved forms and properties. Let us tell you more about these efficient, economical desiccants. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 0164 Gulf Building, Pittsburgh 19, Pa.

Alcoa Chemicals

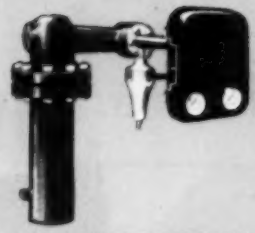
ALCOA

ALUMINAS and FLUORIDES

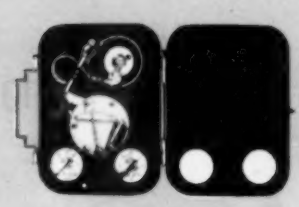
ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUORBORIC ACID • CRYOLITE • SYNTHETIC CRYOLITE



BACK PRESSURE REGULATOR
TYPE 196



LIQUID LEVEL CONTROLLER
TYPE 888



PRESSURE CONTROLLER
PILOT TYPE 1400

TIME CYCLE CONTROLLER
TYPE 995

IN THE OIL & GAS INDUSTRIES

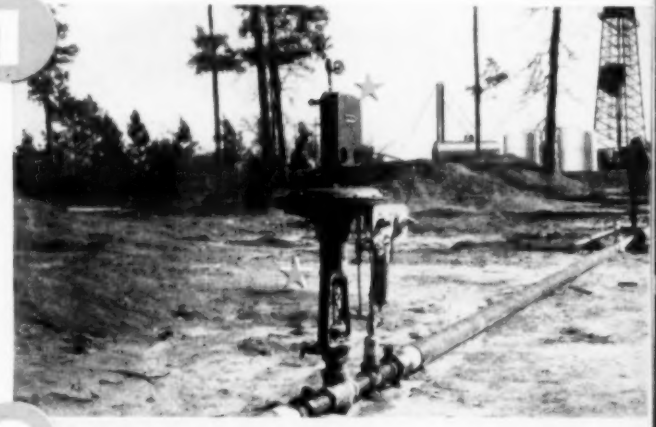
CLIMAX

Place an orange star on every Climax Control and Regulator used in the oil and gas business and you'd give the entire industry the appearance of a constellation on earth. Climax Controls are so numerous . . . their applications so varied you'll find them wherever there is the smell of gas or crude; wherever men behind closed gates process and refine to get the many products that spring from oil and gas.

DRILLING 1

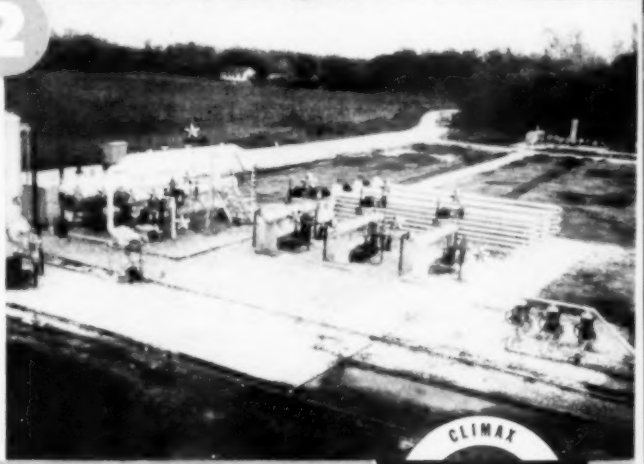
Even here ...at the very beginning...

you'll find Climax represented. At the drilling rig you're quite likely to see Climax Diaphragm Control Valves and Climax Fuel Supply Regulators. And as you progress still further into the various steps of the oil and gas industry you find Climax playing many vital roles.



PRODUCTION 2

Operators lean heavily on Climax here. Around the wellhead there are Climax Controllers—Safety Shut-Off Regulators . . . Pressure Reducing and Back Pressure Regulators . . . Time Cycle Controllers for gas lift wells. For field gathering systems there are Climax Liquid Level Controllers, 3-way Valves, Pressure Controllers and Diaphragm Motor Valves used on dehydrators and desulfurizers. Climax Pressure Controllers are used on separators, low temperature separation units, BS&B Glycol Injection Systems (pictured here), emulsion treaters, free water knockouts, BS&B Stabilizers, indirect heaters and for automatic tank battery controls.

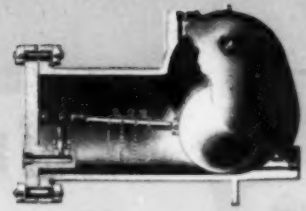


The Story of Climax Controls is a book in itself.

We would like you to have this book for ready reference. Several sections have been recently revised to cover new and improved Climax Controls. So that your business can keep up with consumption demands BS&B keeps Climax Controls ahead of the trend, to give you the very best and latest control and regulator equipment. Let us send you this book . . . it's FREE. Or, ask your BS&B Man. There are 76 Climax Control Centers to help you.

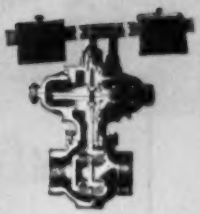
CLIMAX
BS&B
CONTROLS

PRESSURE REDUCING REG.
TYPE 260



DUO-PHASE CONTINUOUS DRAINER
TYPE 90

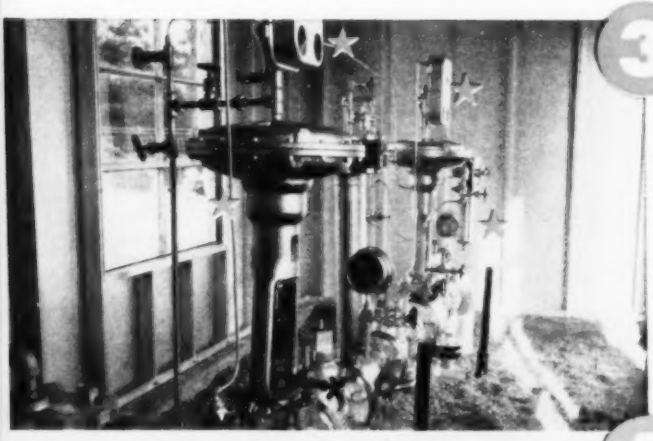
DIAPHRAGM CONTROL VALVE
TYPE 86



VACUUM REGULATOR
TYPE 8

CONTROLS* serve right down the line

. . . from drilling rig through refining



3 GAS PIPE LINES

and Compressor Stations

The mission of Climax Controls carries right on through. Around gas pipelines and compressor stations the Climax name appears on many pressure controllers, diaphragm motor valves, drainers and traps. All along oil pipelines are Climax automatic controls for pump operation.

4 REFINING

Gasoline Plants and Petro-Chemical Plants

In this final stage of a major industry Climax Controls are very much in evidence. Throughout these orderly and concentrated jungles of piping, heat exchangers, vessels and ladders Climax does almost every conceivable regulating job, with Liquid Level Controllers, Pressure Controllers, Diaphragm Control Valves, Pressure Regulators and Relays.

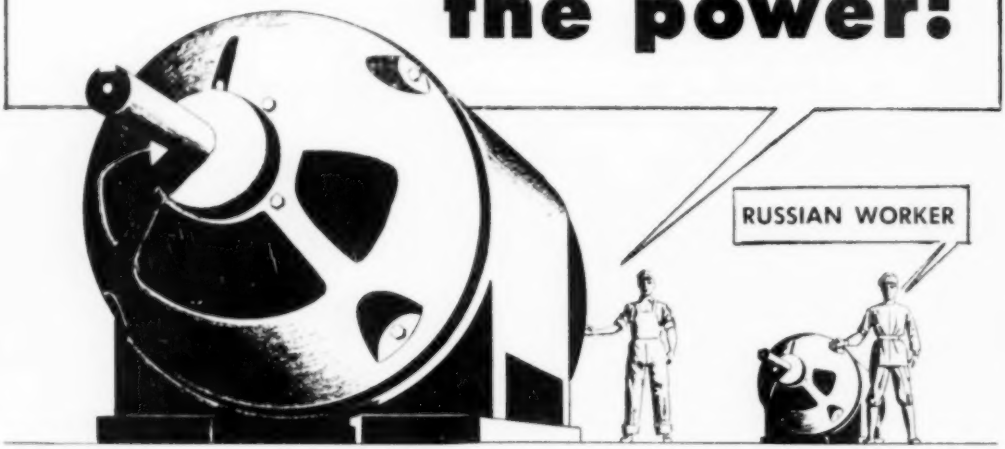
BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division Dept. 4-D11

7500 East 12th Street

Kansas City 3, Missouri

AMERICAN WORKERS HAVE 7 times the power!



How does America do it?

Why does the American worker have the help of about 7 times as many kilowatt-hours of electric power as is available to the Russian worker?

How can we Americans produce over 40% of the world's goods and bring so much more of everything to everybody with less than 6% of the world's population? Why is the American output per-man-hour still growing faster and faster?

The answers cannot be laughed off nor are they hard to find. In the words of Ralph J. Cordiner, president of the General Electric Company: "The greatest impetus for forward movement still comes when individuals are free to plan and carry out their own ideas without government coercion or unnecessary regulation."

Including estimated expenditures in 1952, private industry in the last seven years will have invested over 150 billion dollars in new plant and equipment. This contrasts with Federal Government investment of not much more than 12 billion for similar purposes in the same period. Moreover most such Government expenses during the last three years have been allocated to military and atomic projects.

Back of all this progress in private industry is the unique American system of competition—our kind of competition that continually stimulates Americans to make things better and to sell them better—and at lower prices.

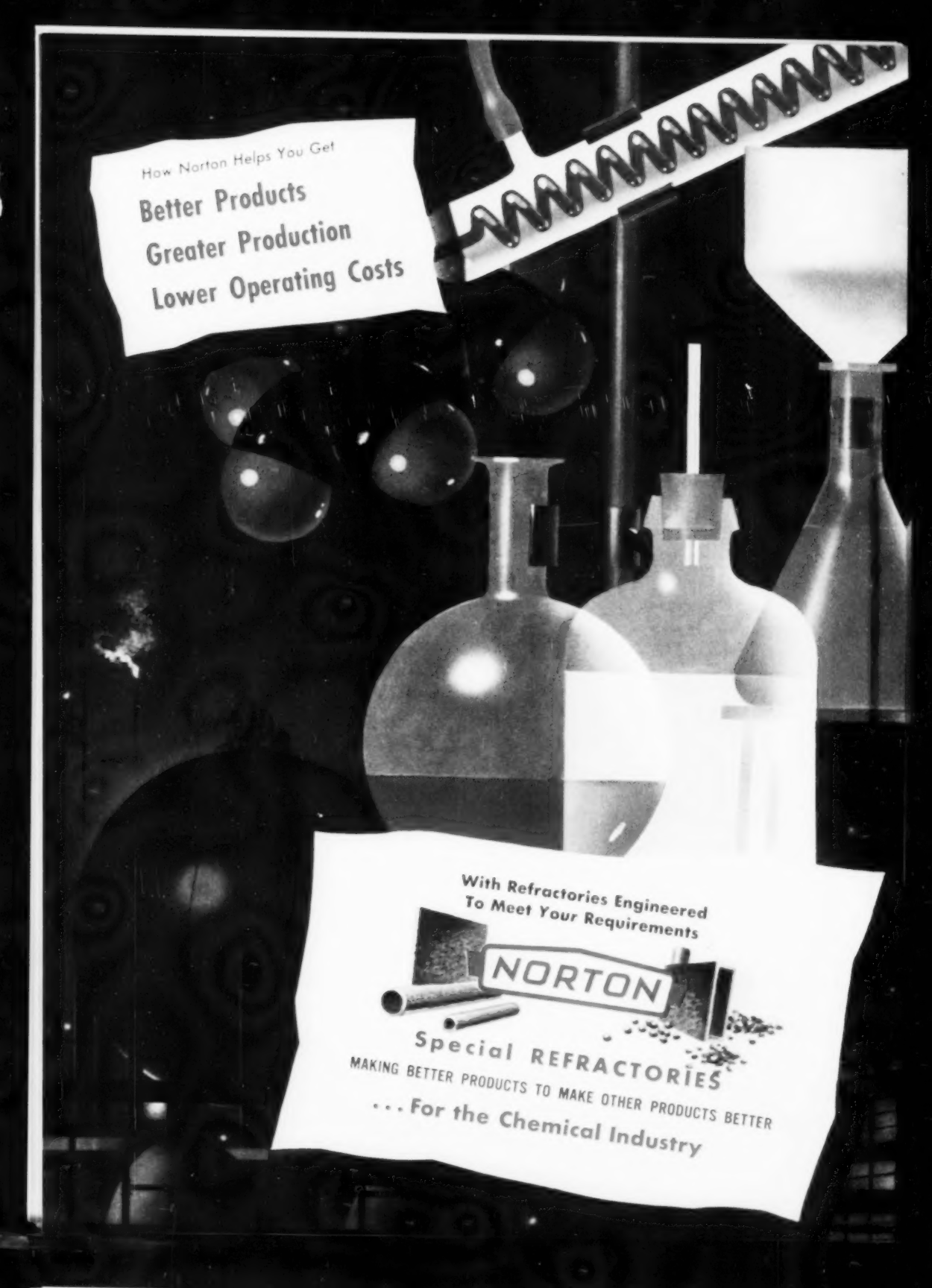
In America we do not just compete for public office; we also compete in technology, competency of management, individual initiative and distribution—the latter including selling and advertising in all their varied forms.

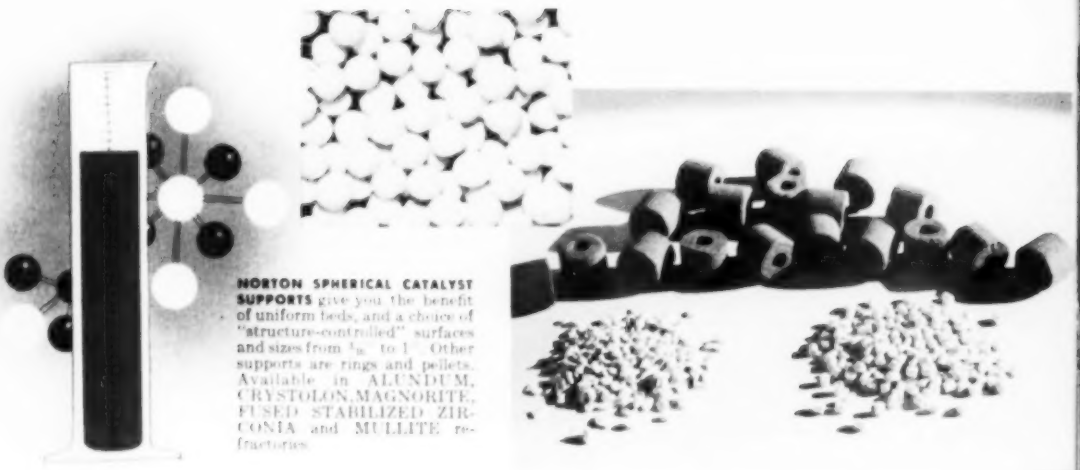
Our kind of competition promotes the growth of more and more businesses and industries—and this means more jobs and expanding prosperity from which we all benefit.

"Planned economies" and other fancy theories are not for us. The American competitive system has given us the highest standard of living in the world. Let's all work to preserve it.

This report on PROGRESS-FOR-PEOPLE is published by this magazine in cooperation with National Business Publications, Inc., as a public service. This material, including illustrations, may be used, with or without credit, in plant city advertisements, employee publications, house organs, speeches, or in any other manner.

THE COMPETITIVE SYSTEM DELIVERS THE MOST TO THE GREATEST NUMBER OF PEOPLE


How Norton Helps You Get
Better Products
Greater Production
Lower Operating Costs
With Refractories Engineered
To Meet Your Requirements
NORTON
Special REFRACTORIES
MAKING BETTER PRODUCTS TO MAKE OTHER PRODUCTS BETTER
. . . For the Chemical Industry



NORTON SPHERICAL CATALYST SUPPORTS give you the benefit of uniform beds, and a choice of "structure-controlled" surfaces and sizes from $\frac{1}{8}$" to 1". Other supports are rings and pellets. Available in ALUNDUM, CRYSTOLON, MAGNORITE, FUSED STABILIZED ZIRCONIA and MULLITE refractories.

You Improve Processes, Increase Yields or Cut Costs

When Norton SPECIAL Refractories are ENGINEERED for You

In your business, you keep going ahead *only* when you keep looking ahead. So, research into new ways of turning out more and better products at lower unit costs is always important to you.

Your job of looking ahead will be much easier and more rewarding with Norton Refractory Research working for you. For 40 years, we have helped many chemical processing firms solve high temperature problems complicated by chemical, electrical, and physical variables. We could tell you how we helped them. But, most of our work has been on a confidential basis. No doubt, you'd prefer us to work that way with you.

WHAT ARE YOUR PROBLEMS?

Are you looking for better catalyst supports? Are you interested in refractories that will let you increase your processing temperatures? Are you having trouble with porous mediums for filtration, diffusion or aeration? Are you bothered by short-lived refractories in your electric furnaces? Do you want to lengthen the life of your laboratory ware?

If you answered "yes" to any of those questions, Norton Refractory Research can be a big help to you. Let's see why.

NORTON CATALYST SUPPORTS HAVE CONTROLLED STRUCTURE

To what degree do you want your catalyst to adhere to the surface of your supports?

Thanks to Norton Company's patented method of controlling porosity, you can specify exactly what you need.

Take Norton spherical supports, for example. Suppose you want maximum catalyst adherence to surface. You specify our *medium-porosity* spheres. Their porosity ranges from 30% to 35%, *with open pores on the outside surface* only. On the other hand, let's say you want uniform impregnation of the entire support. Then, you specify our *high-porosity* spheres to get greater deposition of your catalyst. Their porosity ranges from 42% to 47%, *with open pores throughout the spheres*. Low-porosity spheres also available if desired.

Both types of Norton spheres are available in diameters from $\frac{1}{8}$" to 1". They provide you with such a uniform bed that channeling and pressure drop are reduced to a minimum.

Other Norton catalyst supports include pellets and rings in diameters from $\frac{1}{8}$" to 2".

Materials used in Norton catalyst supports are ALUNDUM®, CRYSTOLON®, MAGNORITE®, FUSED STABILIZED ZIRCONIA, and MULLITE refractories. Each material has its own special properties as a catalyst support. All have the chemical stability and purity that eliminate contamination of both catalyst and end products. High refractoriness and resistance to abrasion contribute to extra long service life.

Norton ALUNDUM Catalyst Supports, in particular, are currently in great demand. They are being used with great success in the manufacture of phthalic anhydride and ammonia and in reforming natural gas. Containing 77% to 89% alumina, they are outstanding for their chemical stability and resistance to abrasion.

Norton ALUNDUM Heat Exchange Pebbles are another product of Norton Research. Because of their high alumina content (95 to 99%), they stand up under alternating oxidizing and reducing atmospheres at high temperatures. Their high resistance to abrasion makes them ideal for heat exchange beds of either static or moving type.

NORTON STABILIZED ZIRCONIA STANDS 4700° F TEMPERATURE

Here's real evidence that Norton Refractory Research can help you look ahead to the higher temperatures that mean greater yields and increased efficiency.

Norton Company was the first to bring fused stabilized zirconia out of the experimental stage early in 1951 . . . and offer it in commercial quantities. Since that time, it has proved itself in many processes.

No other refractory is so chemically stable at such high temperatures under both oxidizing and reducing conditions. In gas synthesis processes, for example, furnaces lined with Norton FUSED STABILIZED ZIRCONIA have stood up for long periods at temperatures approaching 4700° F in a neutral to slightly reducing atmosphere.

Other properties that have won interest in Norton FUSED STABILIZED ZIRCONIA are its low thermal conductivity (6.2 BTU in dense shapes at 2000° F, and its high electrical conductivity at elevated temperatures.

Bulletin No. 1409 gives you the whole story on the properties and applications of Norton FUSED STABILIZED ZIRCONIA.

Other Norton Refractories for furnaces include ALUNDUM, CRYSTOLON and MAGNORITE mixtures in brick, plates, tubes, and blocks. Each is engineered to fit your exact requirements.

Strange to relate, Norton Refractory Research has proved to a number of firms, attracted by the amazing properties of STABILIZED ZIRCONIA, that another engineered Norton special refractory was better for them.

It will pay you, too, to call on Norton Refractory Research to work with you.

NORTON ALUNDUM POROUS MEDIUMS MAKE UNIFORM FLOW CERTAIN

Here, again, Norton Company's patented "controlled structure" process comes to your assistance.

REMEMBER, ALL THE NORTON SPECIAL REFRACTORIES DESCRIBED HERE CAN BE ENGINEERED TO FIT YOUR EXACT REQUIREMENTS—

In porous mediums for filtration, diffusion or aeration, you want to be sure of uniform flow. And you're always sure when you use Norton porous plates, tubes, discs or diaphragms. That's because their pores are uniformly distributed, in the size and open-pore ratio you need.

Norton seamless porous tubes, for example, are now being widely used for filtering water, solvents, cutting oils, wine, food oils and other liquids . . . for reclaiming cleaning fluids . . . in boiler feed water treatment . . . and for handling industrial oil wastes. Their *seamless* construction makes porosity uniform . . . maintains constant air or liquid pressure . . . lets back-washing do a more thorough cleaning job.

Of equal importance to you is the material used in Norton porous mediums. It's Norton ALUNDUM aluminum oxide . . . a tough abrasive and a chemically stable refractory at the same time.

Because of these properties, Norton ALUNDUM porous mediums survive conditions that shorten the life of other products. They are relatively unaffected by the acid or alkaline conditions normally encountered in commercial applications. Their great strength and extreme resistance to abrasion give them extra long life. Their resistance to properly applied temperatures up to 1850° F permits you to burn off organic matter if it clogs the pores.

Custom-made in the sizes and shapes you need, Norton ALUNDUM porous plates, tubes, discs or diaphragms will give you the uniform flow you want at the lowest possible annual cost. *Bulletin No. 150 tells you more.*

NORTON ELECTRIC FURNACE SHAPES GIVE TOP PERFORMANCE LONGER

If electric furnaces are as important to you as they are to us, you'll get more help than you can imagine out of Norton Refractory Research.

They're so important in so many vital phases of our own business that we're always looking for new ways of improving their performance.

We have had great success with Norton ALUNDUM cores, muffles, and tubes. There are four reasons why:

1. Norton ALUNDUM furnace parts are made of fused aluminum oxide that is 99+% Al_2O_3.

2. Such purity results in a high degree of stability and chemical inertness. This prevents reactions with resistor materials as well as crucibles and boats of platinum, nickel or fused oxide.

3. Norton ALUNDUM furnace shapes are excellent thermal conductors. This means small temperature gradient between the resistor and furnace interior.

4. Norton ALUNDUM refractory is a good electrical insulator up to relatively high temperatures. One test on an ALUNDUM tube shows a direct current resistance of 7.5×10^5 ohms cm^3 at 600° C. This value did not fall off materially until a temperature in excess of 1600° C was reached.

Where high thermal conductivity and resistance to heat shock are more important, Norton CRYSTOLON shapes offer advantages over ALUNDUM shapes. They are limited, however, to resistors of nickel chromium alloys and to temperatures not exceeding 2100° F.

Norton FUSED STABILIZED ZIRCONIA shows great possibilities as induction heating elements in ultra high frequency induction furnaces and as resistors in high temperature resistance furnaces.

Bulletin No. 458, titled "The Construction of Electric Furnaces for the Laboratory" is yours for the asking.

NORTON ALUNDUM LABORATORY WARE OFFERS YOU MANY ADVANTAGES

No other laboratory ware combines so many of the properties you want for your laboratory development, experimental or analytical work.

1. It's chemically stable. Made of fused alumina containing 85% Al_2O_3 99+%, in special mixtures, it is not attacked by any organic solvent. Only hydrofluoric acid, concentrated phosphoric acid and strong, hot caustic solutions affect it.

2. It stands temperatures up to 1900° C. So, you can melt pure metals in thick-walled Norton ALUNDUM crucibles. You can also ignite extracted residues in Norton ALUNDUM thimbles.

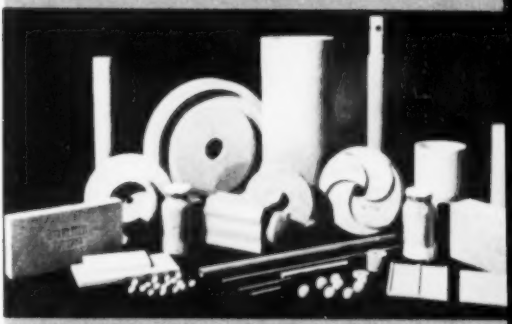
3. It's easy to clean. You just dip it briefly in a fairly strong acid solution (not phosphoric, hydrofluoric or concentrated sulphuric); wash with water, and ignite to constant weight.

4. For filtering, it comes in four degrees of permeability to retain 0.1, 5.0, 20.0 and 30 microns particle sizes.

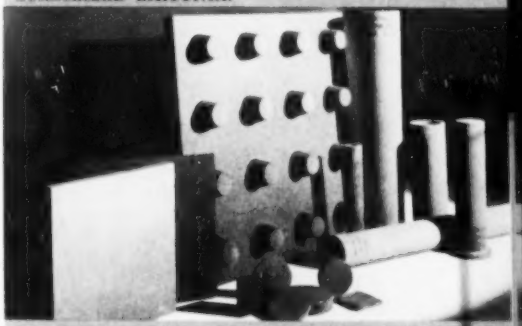
Bulletin No. 793 tells you all about Norton ALUNDUM Laboratory Ware. Get it from your regular source of laboratory ware, or write us direct.

LET'S TALK IT OVER.

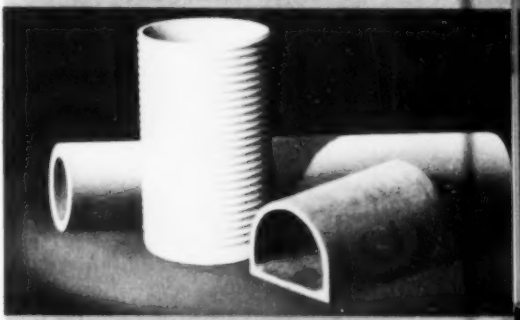
*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries



NORTON REFRACTORY SHAPES FOR REACTION FURNACES come in bricks, plates, tubes and blocks in ALUNDUM, CRYSTOLON, MAGNORITE and FUSED STABILIZED ZIRCONIA.

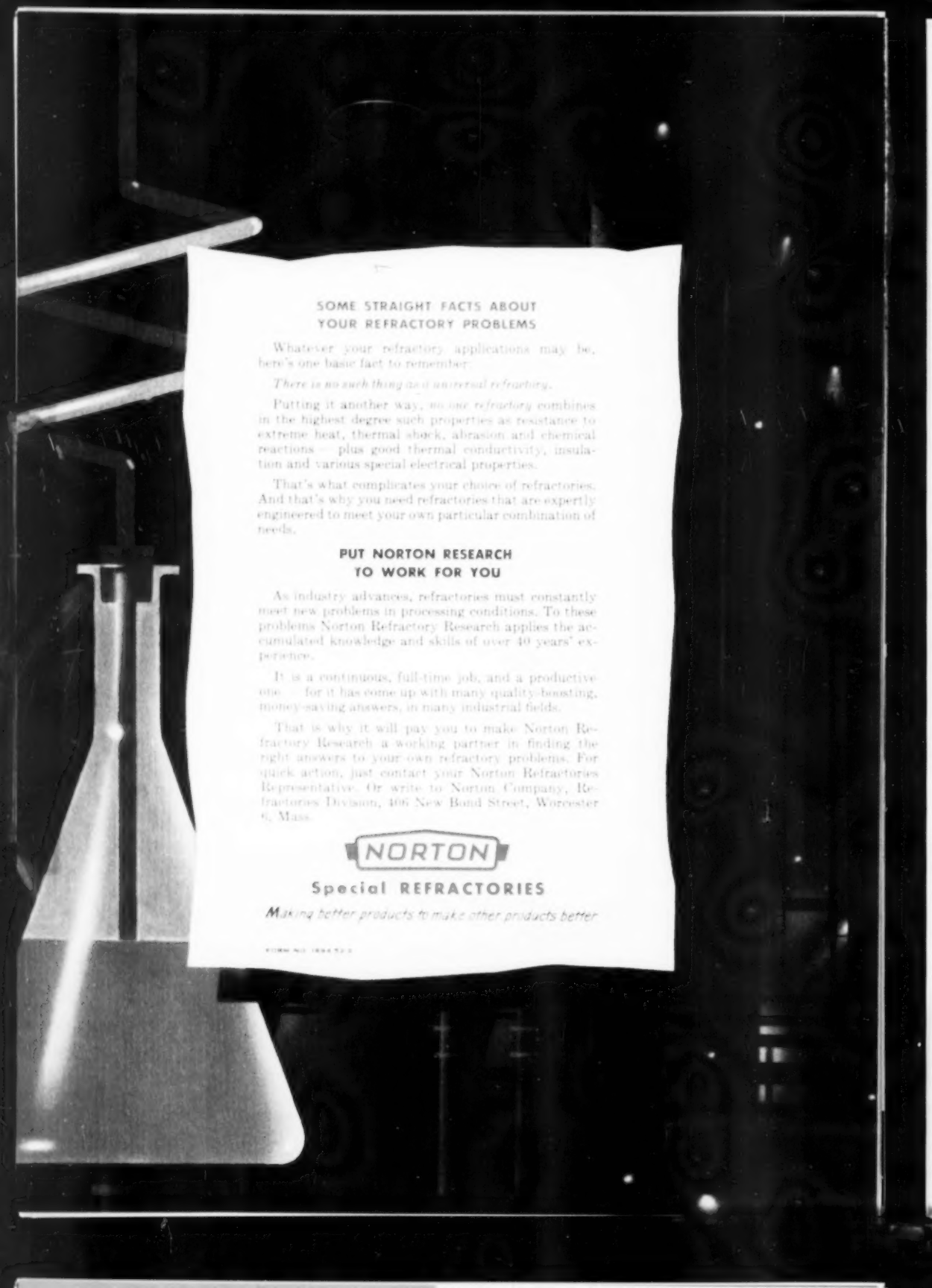


NORTON ALUNDUM POROUS MEDIUMS come in plates, tubes, discs and diaphragms engineered to fit your exact filtering, diffusing or aerating requirements.



NORTON ELECTRIC FURNACE REFRACTORIES come in cores, tubes, and muffles made of ALUNDUM and CRYSTOLON refractories.

NORTON ALUNDUM LABORATORY WARE, famous for its chemical stability, high refractoriness and uniform porosity, comes in crucibles, ignition capsules, incinerating dishes, cones, dishes, discs, thimbles and boats in all sizes and shapes.



SOME STRAIGHT FACTS ABOUT YOUR REFRACTORY PROBLEMS

Whatever your refractory applications may be, here's one basic fact to remember:

There is no such thing as a universal refractory.

Putting it another way, *no one refractory* combines in the highest degree such properties as resistance to extreme heat, thermal shock, abrasion and chemical reactions — plus good thermal conductivity, insulation and various special electrical properties.

That's what complicates your choice of refractories. And that's why you need refractories that are expertly engineered to meet your own particular combination of needs.

PUT NORTON RESEARCH TO WORK FOR YOU

As industry advances, refractories must constantly meet new problems in processing conditions. To these problems Norton Refractory Research applies the accumulated knowledge and skills of over 40 years' experience.

It is a continuous, full-time job, and a productive one — for it has come up with many quality-boosting, money-saving answers, in many industrial fields.

That is why it will pay you to make Norton Refractory Research a working partner in finding the right answers to your own refractory problems. For quick action, just contact your Norton Refractories Representative. Or write to Norton Company, Refractories Division, 406 New Bond Street, Worcester 6, Mass.

NORTON

Special REFRACTORIES

Making better products to make other products better

QUESTION

To What Extent is Du Pont Responsible for Tetraethyl Lead Antiknock Compound?

ANSWER

DU PONT is wholly responsible for developing the only safe commercial method of producing tetraethyl lead.

And, from 1923 to September 1945, Du Pont was the sole user of this method and the only manufacturer of TEL in the United States.

Today, wherever tetraethyl lead is made, the basic principles developed by Du Pont are still in use. But, in Du Pont plants only, a new and better method will soon be introduced. This too is exclusively a development of Du Pont's experience and research.

The many Du Pont services available to refiners, like its manufacturing facilities, are based on 150 years of continuous research and sound business practice. That's why more and more refiners are calling on Du Pont for technical advice and research assistance as well as marketing help and other services.

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

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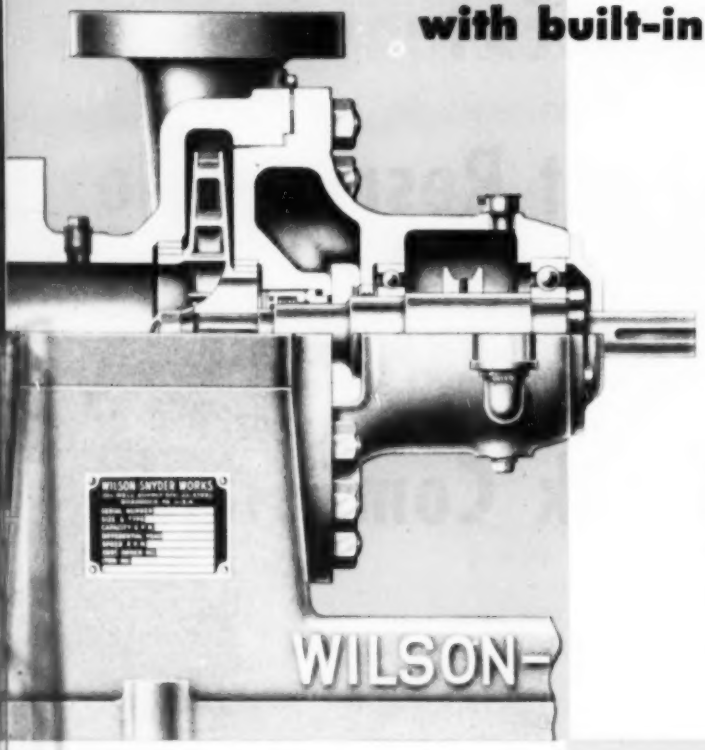
an addition to the line of Wilson-Snyder Pumps!

Type ESC PROCESS CENTRIFUGALS

with built-in mechanical seal



9 sizes

from

- *15 to 1200 GPM Capacity*
- *40 to 470 Feet Head*
- *Subzero to 250° Fahrenheit*
- *15 to 750 p.s.i. Discharge*
- *2 to 100 Horsepower*

Type ESC horizontal, single-stage centerline supported centrifugal pumps with vertically-split case are heavy-duty pumps specifically designed for a mechanical seal. They have a spacer-type coupling and sloping-top drain base plate. At minimum cost, they provide rugged, dependable, and fool-proof construction for continuous and efficient operation.

1. Built-in balanced mechanical seal eliminates gland, packing, sleeve, and set screws. Only one seal size is used for all pump sizes.

2. Short overhang of impeller reduces shaft deflection, vibration, and length of pump.

3. Large streamlined impeller eye results in low NPSH requirements.

4. Parts are highly interchangeable between all sizes, minimizing inventory.

5. Wearing parts can be replaced without disturbing case, piping, or driver.

6. Extra strong case and bearing bracket design assure true alignment and smooth operation.

7. Wear rings on both sides of impeller minimize thrust and stuffing box pressure.

FOR FULL INFORMATION . . . or quotations on Wilson-Snyder Process Pumps, contact "Oilwell's" Refinery Specialist at Area Office points shown below, or Wilson-Snyder Works, Braddock, Pennsylvania

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ANACONDA Arsenical Admiralty—

a practical solution to tube dezincification

What causes dezincification?

Metallurgical research indicates a number of conditions causing dezincification of condenser and heat exchanger tubes:

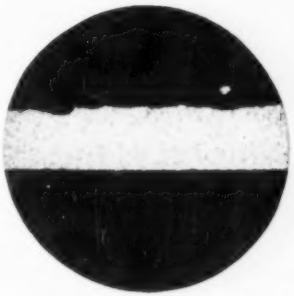
LAYER TYPE dezincification tends to be the result of a critical degree of acidity of the cooling water.

PLUG TYPE dezincification is more apt to occur where the cooling water is neutral or alkaline.

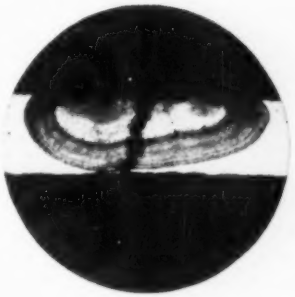
LOW WATER VELOCITY may accelerate dezincification by failing to wash away copper salt solutions, thereby permitting redeposition of copper.

HIGH COOLING WATER TEMPERATURES hasten over-all corrosion reactions and seem to favor the electrochemical process causing redeposition of copper.

LOW OXYGEN CONTENT of cooling water is also considered a factor in accelerating the redeposition of copper.



Longitudinal section through Arsenical Admiralty tube. No evidence of dezincification. Characteristic microstructure. 7×



Longitudinal section through wall of one Arsenical Admiralty tube showing extensive plug type dezincification starting from outside surface. 7×

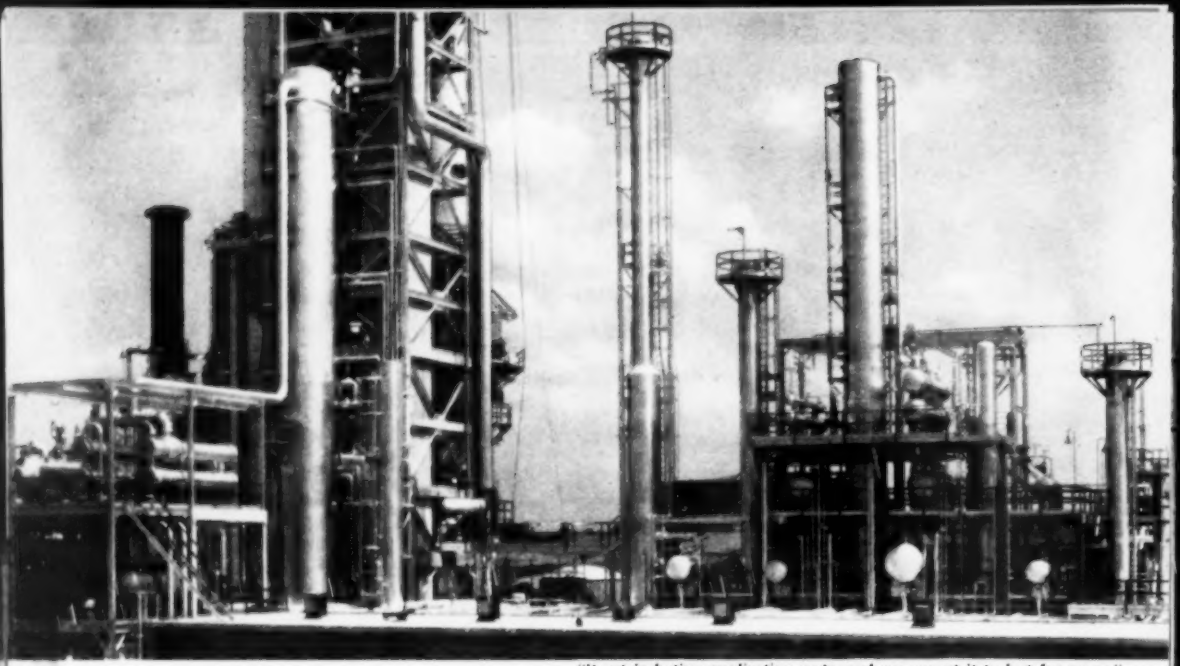
Arsenic as an Inhibitor

Laboratory studies and field installations have clearly indicated the effectiveness of small quantities of arsenic in Admiralty and other copper alloys as an inhibitor to dezincification. The inhibating action of arsenic, as well as of other inhibitors, is not well understood. One theory holds that the inhibitor covers anodic areas to prevent initial selective corrosion; another states that it forms a film of an electropotential equal to that of the copper to prevent the copper redepositing.

For Technical Counsel

The files of Anaconda's Technical Department and the experience of its engineers cover the case histories of condenser and heat exchanger tubes operating under the widest variety of conditions. These are freely available to you to help you select the right alloy for your installation. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

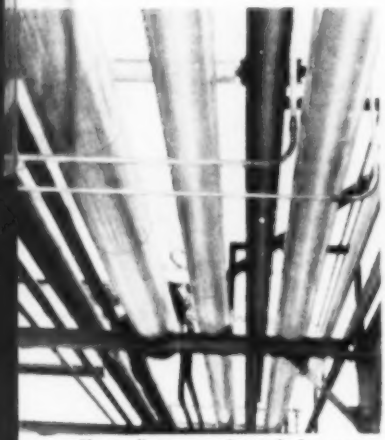
ANACONDA



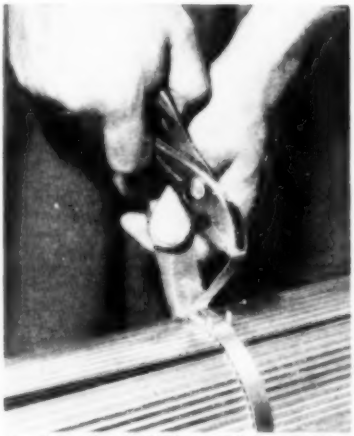
"It cut jacketing application costs, and we expect it to last for years," report engineers at refineries everywhere after testing Childers Aluminum Jacketing on their insulated lines. This new Oklahoma refinery used Childers 100% — on towers and vessels (in heavy weight) as well as on lines. It is flexible and easy to put on, and this 35 alloy aluminum is tough and weather-resistant, even in corrosive industrial atmospheres. This is the first and only jacketing especially engineered for process plants and power installations.

Refineries cut maintenance on insulated lines by switch to new low-cost aluminum jacketing

At least 567 processing plants have installed and tested this new Childers Aluminum Weatherproof Jacketing during the last three years. You can examine its advantages for your plant by writing for a free sample. Address Childers Manufacturing Co., Dept. TR-S, 3620 W. 11th St., Houston 8, Texas.



These lines are insured for years against wear and weather. They'll never need painting because Childers Jacketing gives them all the advantages of appearance and long life that come only with weather-resistant aluminum. Yet this specially engineered jacketing costs far less than would heavy aluminum sheets.



As shown here, Childers Jacketing can be attached with no more tools than a pliers and a wooden wedge. No expensive shop work or pre-forming are necessary. Several methods of attaching are available, but aluminum bands shown here are probably best and cheapest. Because this jacketing is so easy to handle and so simple to attach, it cuts installation costs way down.

This is how the flexible, easy-to-handle Childers Jacketing arrives at the job site. It is in convenient rolls 4 feet wide and 100 feet long—just right for one man to handle—and is available either with or without a moisture barrier attached on the back of the .006" aluminum "skin". It can be cut to proper lengths using any flat table and a straight-edge.

Advertisement

Under CMP regulations, Childers is a Class B product, the use of which is not restricted

HERE'S WHY ENGINEERS SELECT YOUNG HEAT EXCHANGERS

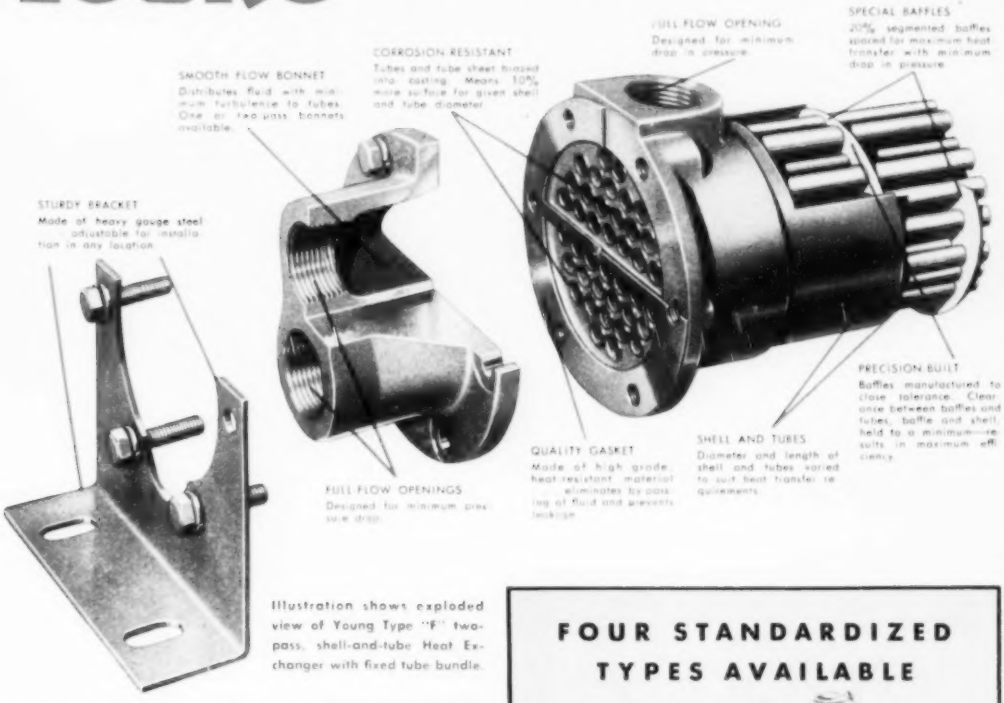

SMOOTH FLOW BONNET
Distributes fluid with minimum turbulence to tubes. One- or two-pass bonnets available.
CORROSION RESISTANT
Tubes and tube sheet brazed into casting. Means 10% more surface for given shell and tube diameter.
FULL FLOW OPENING
Designed for minimum drop in pressure.
SPECIAL BAFFLES
20% segmented baffles spaced for maximum heat transfer with minimum drop in pressure.
STURDY BRACKET
Made of heavy gauge steel adjustable for installation in any location.
FULL FLOW OPENINGS
Designed for minimum pressure drop.
QUALITY GASKET
Made of high grade, heat-resistant material . . . eliminates by passing of fluid and prevents leakage.
SHELL AND TUBES
Diameter and length of shell and tubes varied to suit heat transfer requirements.
PRECISION BUILT
Baffles manufactured to close tolerance. Clearance between baffles and tubes, baffle and shell held to a minimum—results in maximum efficiency.

Illustration shows exploded view of Young Type "F" two-pass, shell-and-tube Heat Exchanger with fixed tube bundle.

COMPACT UNITS . . . PRECISION MANUFACTURED . . . STANDARD DESIGN . . . QUICK DELIVERY

Young standardized Heat Exchangers, recognized for their compactness in design, provide maximum heat transfer per unit volume of available space with minimum weight. They are used for any kind of fluid to fluid cooling. Single or multi-pass units—fixed tube bundle Type "F" and removable tube bundle Type "R"—are available in ferrous and non-ferrous metals and complete range of sizes. Type "F" units are shipped from stock, and Type "R" units are available for quick delivery. Write for catalogs 1049 and 1149.

1927 · 1952
25 YEARS OF PROGRESS IN HEAT TRANSFER ENGINEERING

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Heat Transfer Products for Automotive and Industrial Applications.

Heating, Cooling, Air Conditioning Products for Home and Industry.

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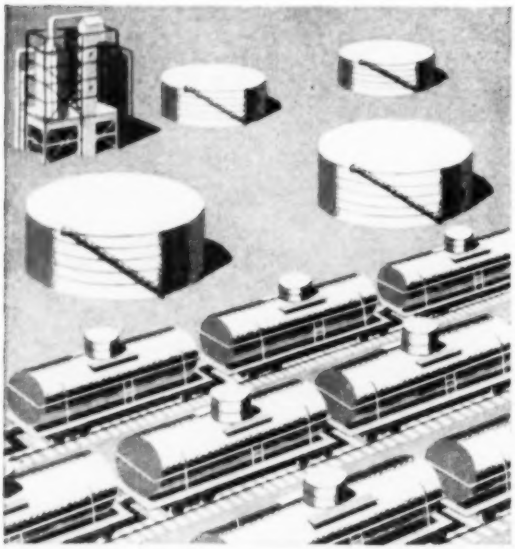
FOUR STANDARDIZED TYPES AVAILABLE

TYPE "F"
Single pass . . . fixed tube bundle . . . in 48 stock models.

TYPE "F"
Two pass . . . fixed tube bundle . . . in 48 stock models.

TYPE "R"
Single pass . . . removable tube bundle . . . in 258 standardized models.

TYPE "R"
Two pass . . . removable tube bundle . . . in 258 standardized models.



More Octane Barrels

EXTRA BARRELS OF HIGH QUALITY GASOLINE FOR THE REFINERY POOL CAN BE HAD THROUGH THE USE OF FILTROL'S LOW COST CRACKING CATALYSTS.

AS SHOWN IN THE EXAMPLE BELOW, HIGHER YIELDS OF CATALYTIC NAPHTHA, GREATER UTILIZATION OF BUTANES FOR PRESSURED GASOLINES, AND THEREBY INCREASED TOTAL GASOLINE YIELDS, ARE POSSIBLE WITH FILTROL CATALYSTS.

REFINERY GASOLINE PRODUCTION

CATALYST	FILTROL FLUID "58"			FILTROL SR			SYNTHETIC SILICA ALUMINA		
GASOLINE	B/D	RVP	BON*	B/D	RVP	BON*	B/D	RVP	BON*
STRAIGHT RUN AND THERMAL	10,000	7.0	68	10,000	7.0	68.0	10,000	7.0	68
REFORMED NAPHTHA	1,792	5.0	84.1	1,790	5.0	84.2	1,873	5.0	82.6
CAT GASOLINE	6,700	4.9	90.5	6,620	7.0	91.5	6,300	7.0	92.5
POLYMER	950	2.5	110	950	2.5	110	950	2.5	110
BUTANE	1,384	68.0	105	1,137	68.0	105	1,127	68.0	105
BLEND	20,826	10.0	81.0	20,497	10.0	81.0	20,250	10.0	81.0

*Blending Octane Number (Research Method)

THESE EXTRA OCTANE BARRELS MEAN EXTRA DOLLARS; AVAILABLE TO CATALYTIC CRACKING OPERATORS EVERYWHERE THROUGH FILTROL CATALYSTS.

OTHER REASONS FOR USING FILTROL CATALYSTS

1. Lowered excess butane
2. High butylene yield
3. Low cost
4. Sulphur resistant catalysts
5. Faster regeneration rate
6. Varied plant facilities
7. Uniformity
8. Technical assistance
9. Low attrition rate

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PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

Filtrol*

CATALYSTS AND ADSORBENTS

*TM. REG. U.S. PAT. OFF.

Where dirt, dust and corrosion are a problem...

TYPE E turbines can handle it!

Spencer Chemical Company of Pittsburg, Kansas, has a total of ten 47-hp Type E turbines for driving blowers. Units are mounted outdoors on structural steel and are exposed not only to the elements, but to a corrosive ammonium-nitrate atmosphere.

Continued satisfactory operation of the turbines under these conditions is proof that the Type E can "take it" . . . proof that Type E construction keeps foreign matter out . . . proof that materials used resist corrosion and erosion.

Weather and corrosion resistance are important . . . in the chemical industry and in other industries as well. Important, too, are other Type E features, such as dual protection against overspeed, floating movement of governing and trip linkages, centerline support, parts interchangeability between wheel sizes. Outstanding Type E design assures safe, trouble-free, economical performance for long periods of continuous operation . . . or instant operation when used as a stand-by drive.

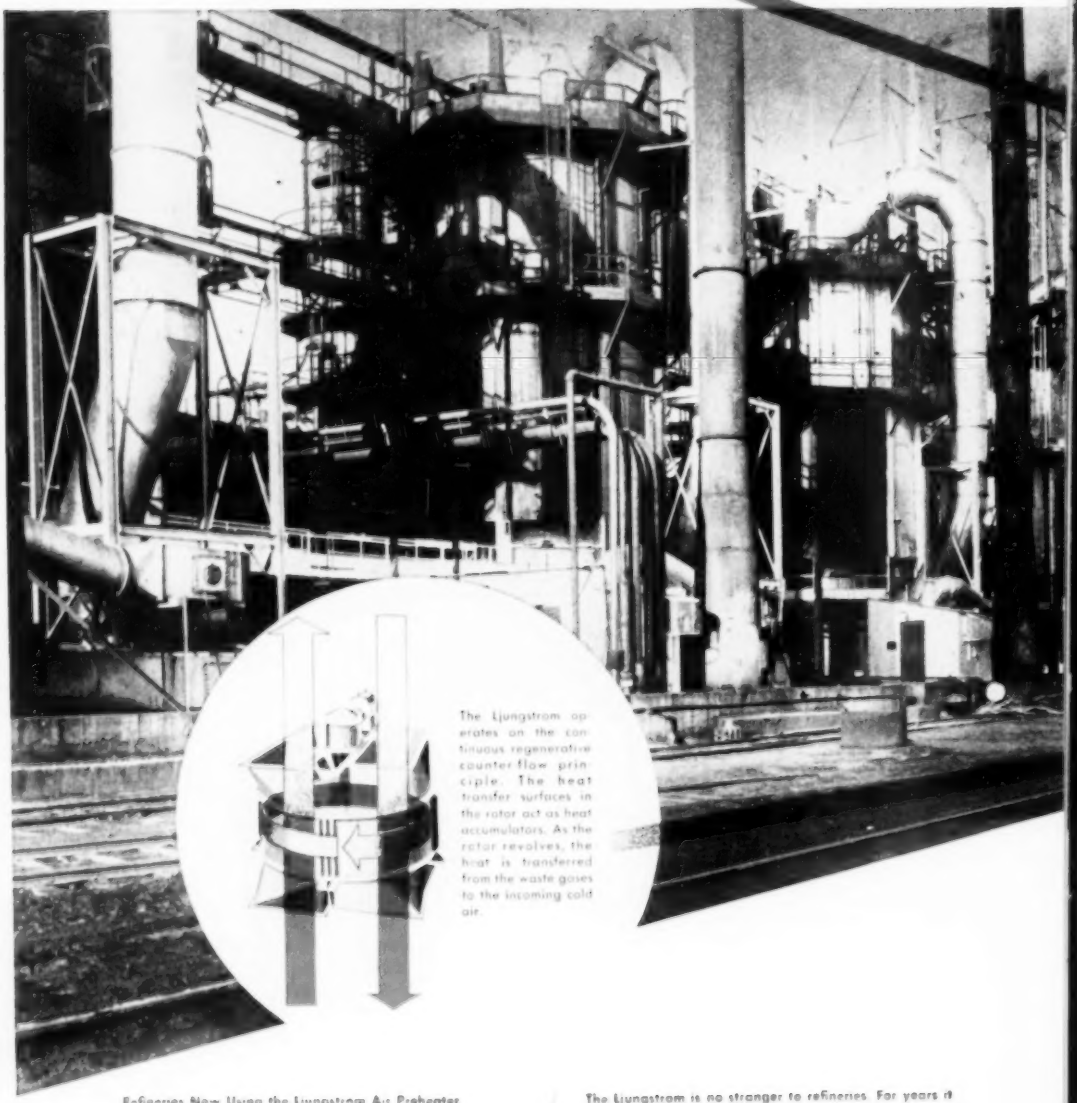
Other types in the complete Westinghouse general-purpose turbine line include heavy-duty and multistage units.

Get the facts from your nearby Westinghouse office, or write for twenty-page book B-3896. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50542

YOU CAN BE SURE...IF IT'S

Westinghouse

TYPE E Turbines



The Ljungstrom operates on the continuous regenerative counter-flow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

Refineries Now Using the Ljungstrom Air Preheater on One or More Process Units . . .

Continental Oil Company
Interocean Oil Company
Le Conselho Nacional de Petroleo Ref.
Lion Oil Company • Ohio Oil Company
Richfield Oil Corporation
Sinclair Refining Company
Socony Vacuum Oil Company
Standard Oil Company of California
Standard Oil Company of New Jersey

The Ljungstrom is no stranger to refineries. For years it has been a standard item for utilizing waste heat from power and process steam boilers. These refineries now use Ljungstrom Air Preheaters on steam boilers . . .

Cit-Con Oil Corporation • Continental Oil Corporation
Esso Standard Oil Company • Humble Oil & Refining Company
Magnolia Petroleum Corporation • Pan-American Refining Company
Phillips Petroleum Company • Shell Oil Company
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Standard Oil Company of New Jersey • The Pure Oil Company
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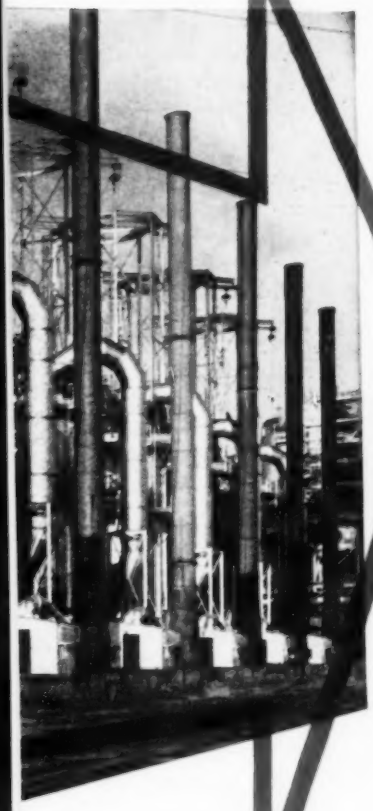
Burn Low Grade Fuels—Efficiently...



...with a Ljungstrom Air Preheater

Low grade tars, pitches and asphalts used to be considered so low in recoverable heat value that they were often discarded. But the Ljungstrom Air Preheater points the way to the practical, efficient use of these former waste products.

Preheated air is a key factor in more efficient combustion, causing faster ignition and a short hot flame. Rates of heat liberation are higher, too. Thus, with preheated air, low grade fuels with high ash and moisture content — and excessively lean fuels — are readily burned.

You get other advantages with a Ljungstrom, too: lower fuel costs . . . more economical furnace design . . . greater throughput . . . higher product quality — *all of these with the Ljungstrom that pays out in just a few months.*

Wherever you are planning to expand or modernize your fuel burning equipment, it will pay you to consider a Ljungstrom Air Preheater. For full information, call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

Consider Ljungstrom Air Preheaters for . . .

Catalytic Cracking
Coking
Petrochemical Production
Petrochemical Separation
Petrochemical Synthesis
Polyforming
Propane Deasphalting
Reforming
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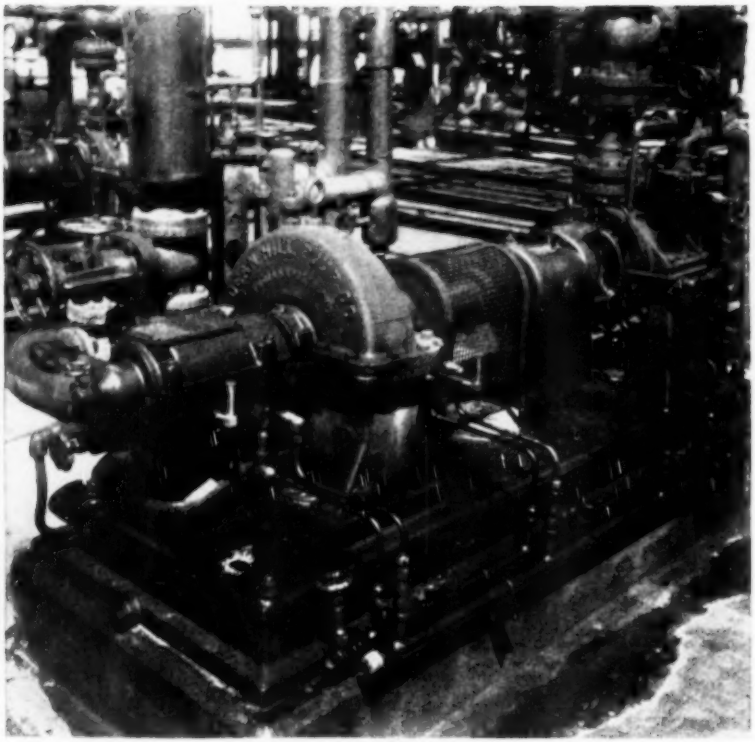
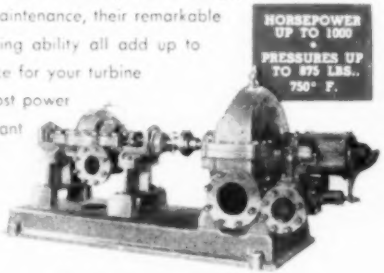


DEAN HILL STEAM TURBINES

are single stage, double impact type for low steam consumption. Specifically designed for operation at medium steam pressures and temperatures, DH Turbines have all the advantages available under these conditions, including excellent water rates. Get the full details and complete specifications. Write today.

POWERFUL "PENNY PINCHER"

Power a-plenty at a penny-pinching cost! That's how DEAN HILL STEAM TURBINES operate. Their super rugged construction, their service-engineered design, their low maintenance, their remarkable power-producing ability all add up to far more service for your turbine dollar. If it's low cost power you want . . . you want DEAN HILL STEAM TURBINES.



DEAN HILL PUMP COMPANY

Pump and Turbine Engineers Since 1895

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Now... closer temperature approaches in heat exchange

WITH TRANE BRAZED ALUMINUM SURFACE

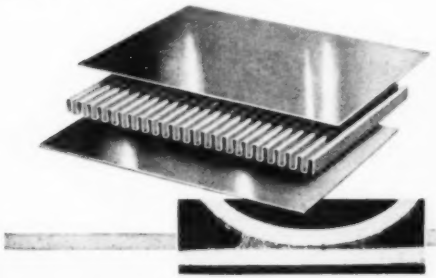
Now . . . even with a large temperature change or drop . . . you can obtain *temperature approaches of 5° to 10° F.*

TRANE Brazed Aluminum heat exchange surface makes it not only possible—but *practical!* That's because the new TRANE Brazed Aluminum packs up to 450 square feet of surface into a single cubic foot of space.

This huge amount of surface in a single unit makes maximum use of available pressure drop. And you don't lose pressure through connections.

TRANE Brazed Aluminum can handle heat transfer between three, four, five or more streams simultaneously —liquid to liquid, liquid to gas, or gas to gas. Temperatures from 500° F. to −300° F. Tested at pressures up to 1000 Psig.

Want more information? Contact your nearest TRANE sales office, or write The TRANE Company, LaCrosse, Wis.



WHAT IS BRAZED ALUMINUM? A stack of flat plates and corrugated fins in layers, all brazed in perfect bond. Strong, light, compact and completely flexible. Illustration below shows strong fillet formed between fin and plate.

MANUFACTURING ENGINEERS OF HEATING, VENTILATING, AIR CONDITIONING AND HEAT TRANSFER EQUIPMENT

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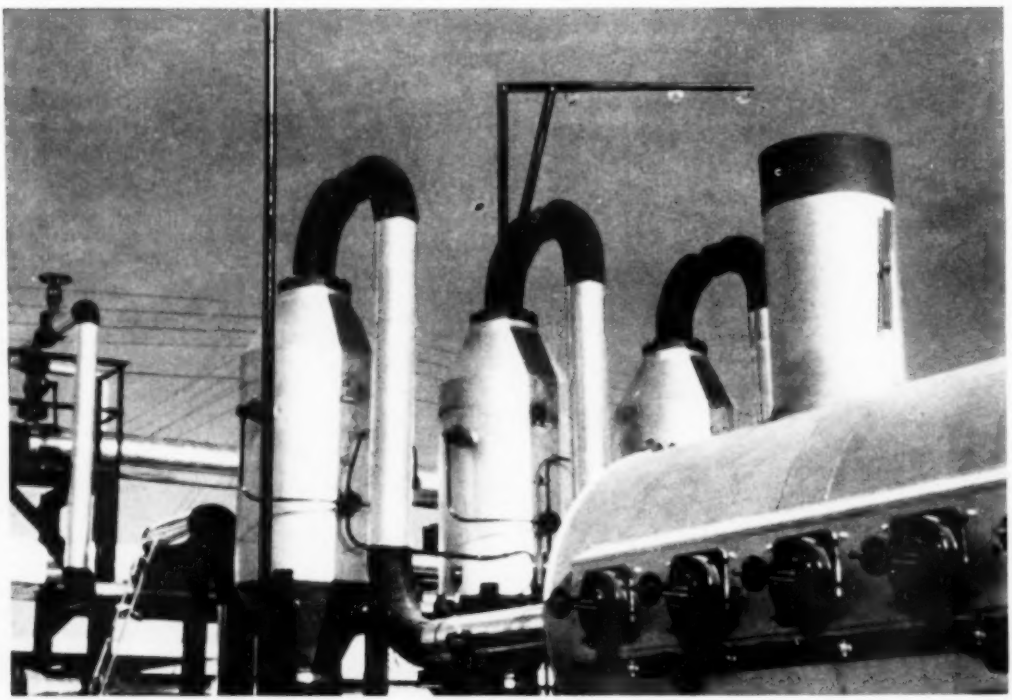
Offices in 80 U.S. and 14 Canadian Cities

CATFORMING...

the Atlantic catalytic reforming process



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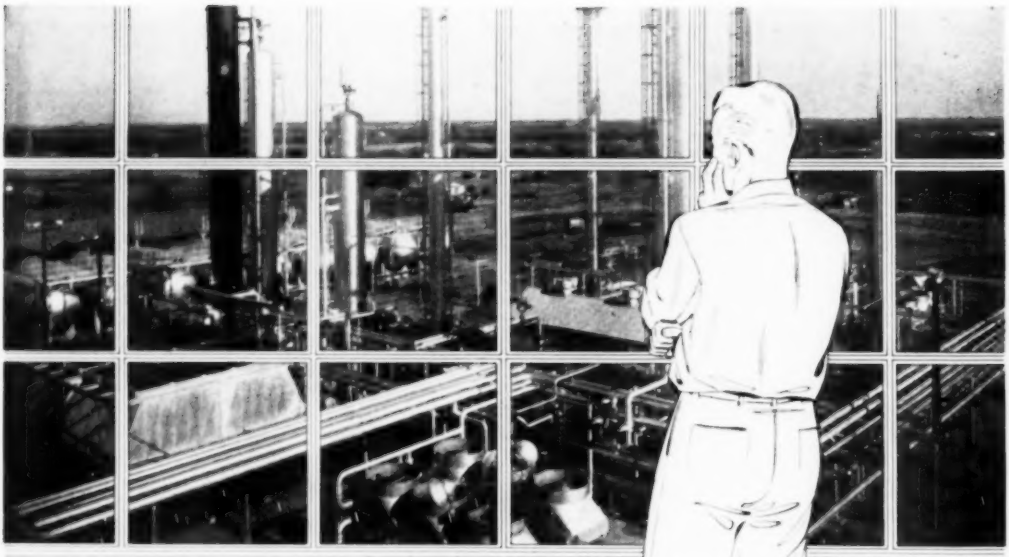

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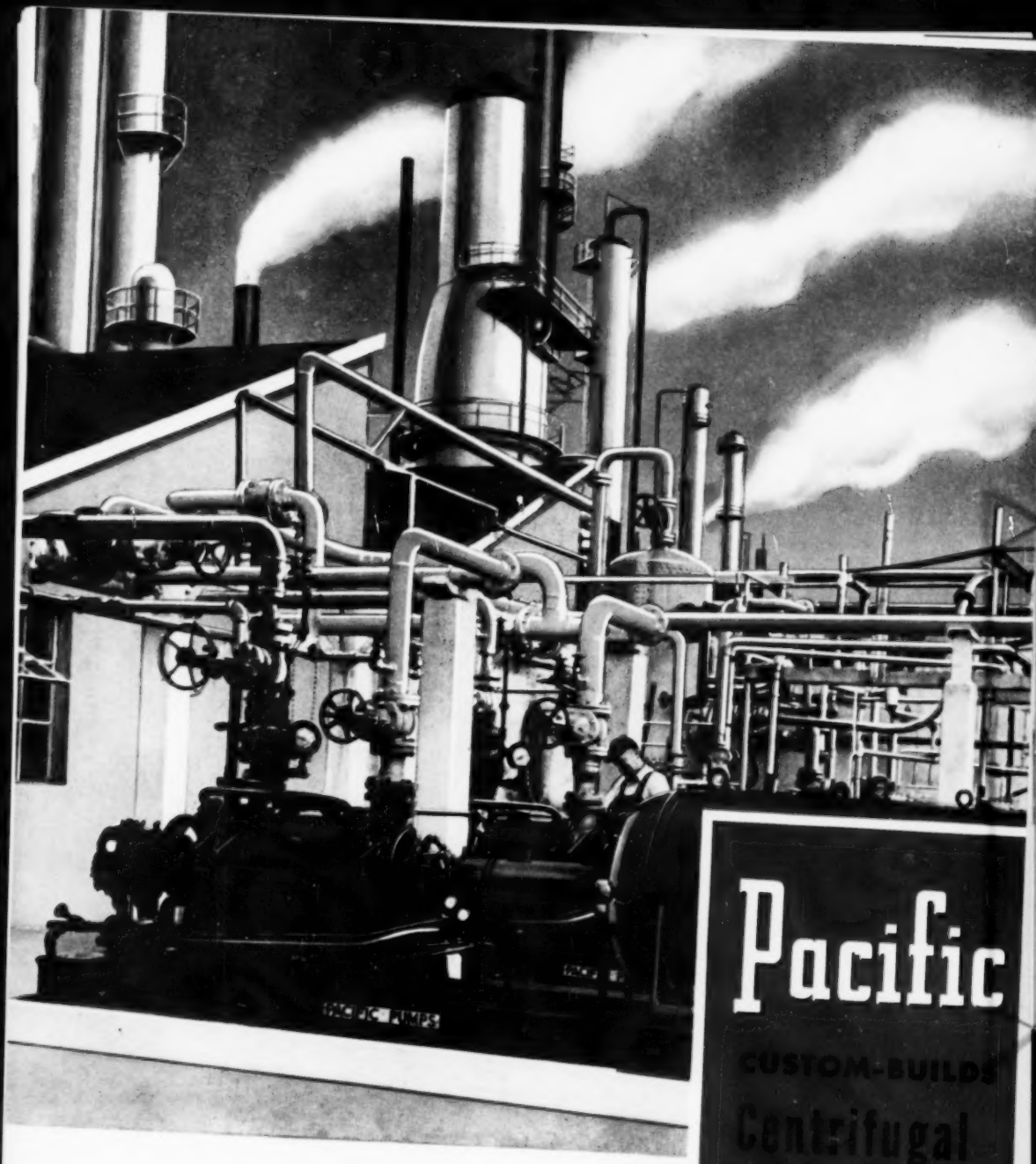

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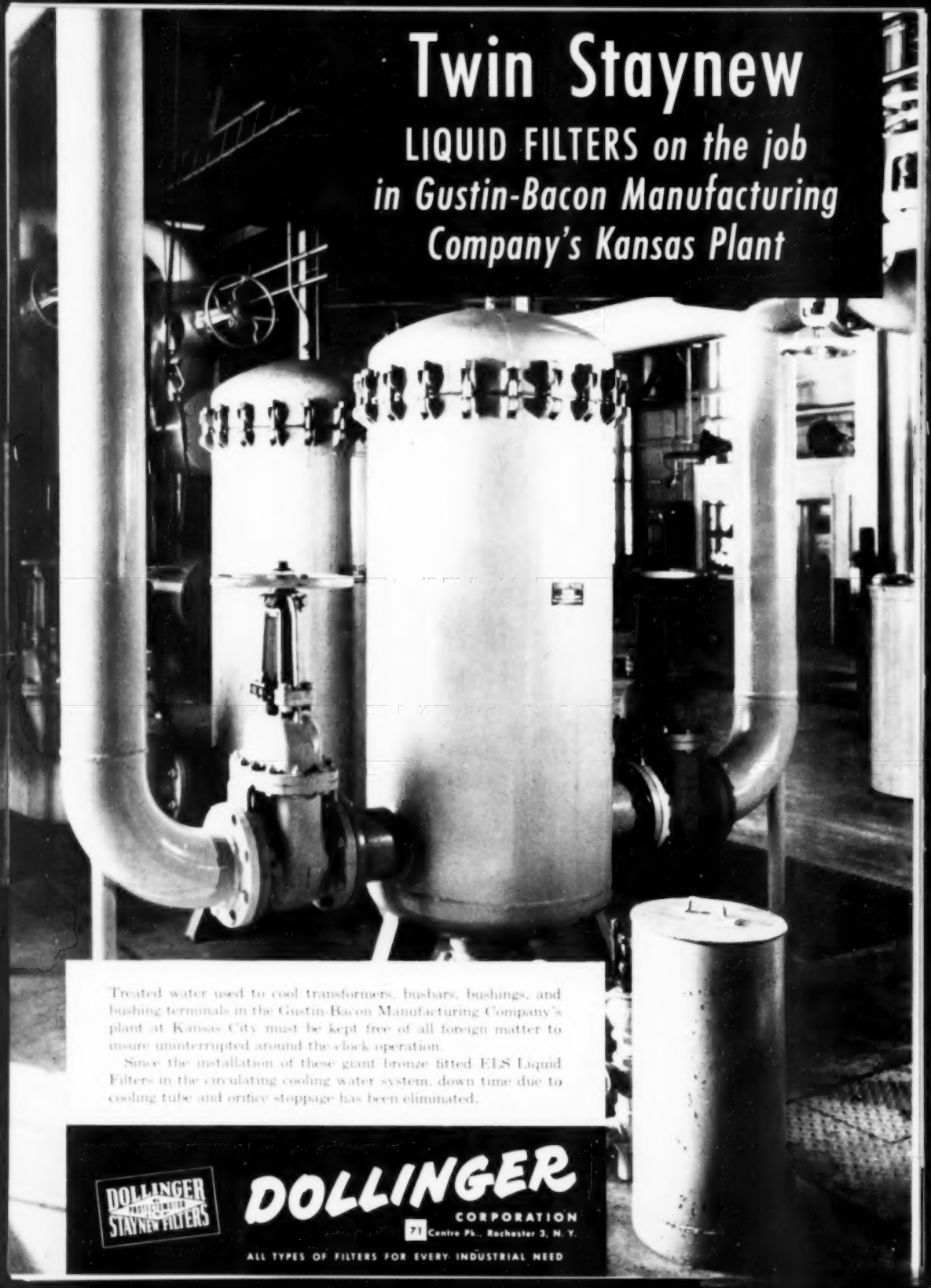

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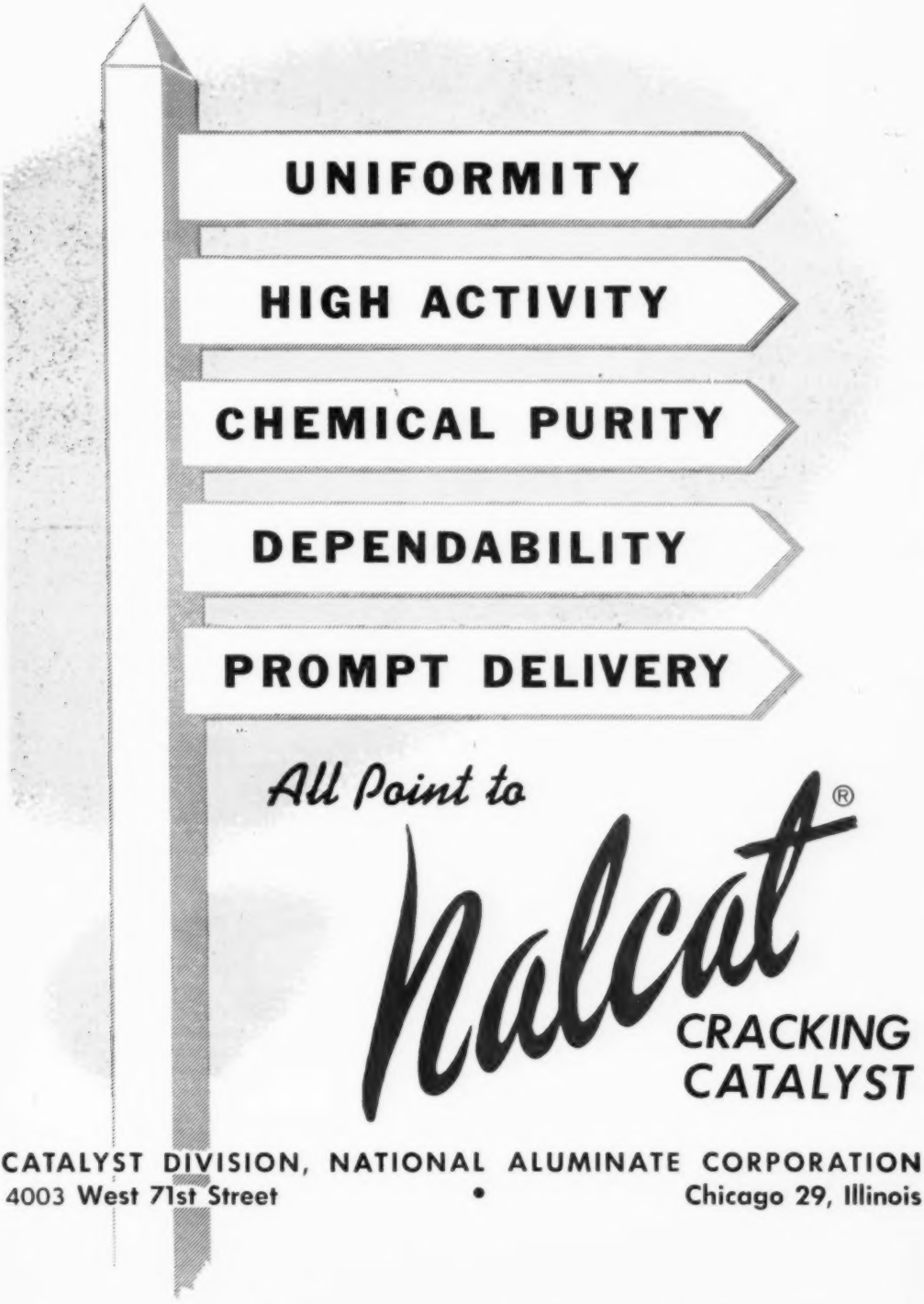

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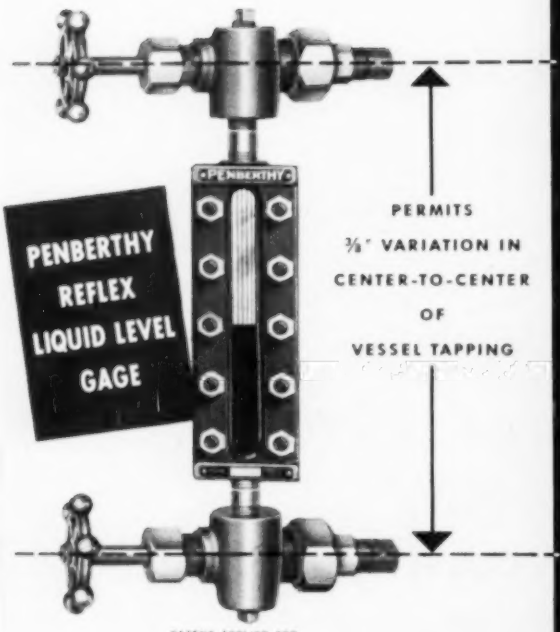

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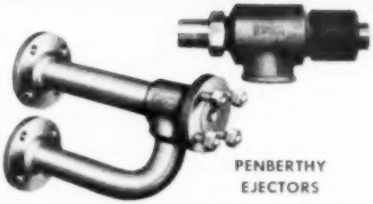

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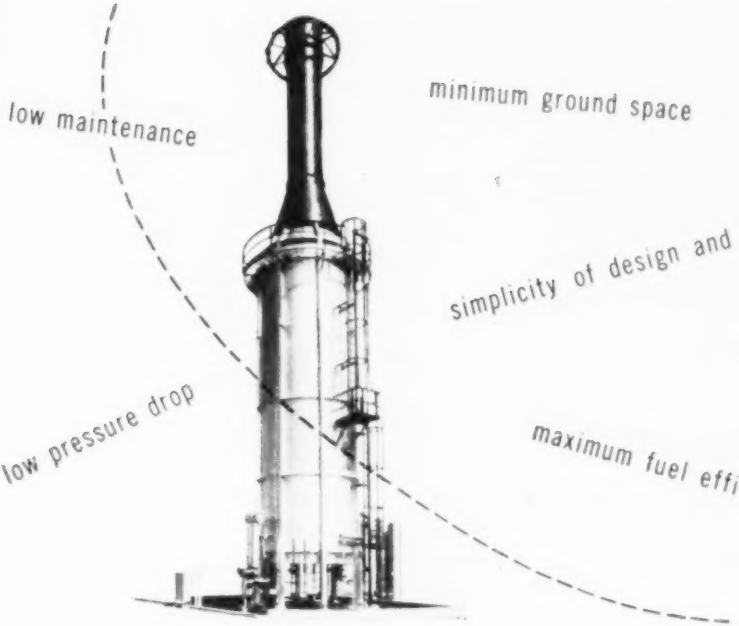

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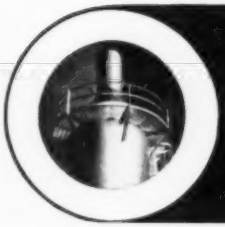

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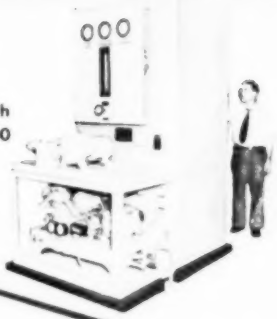

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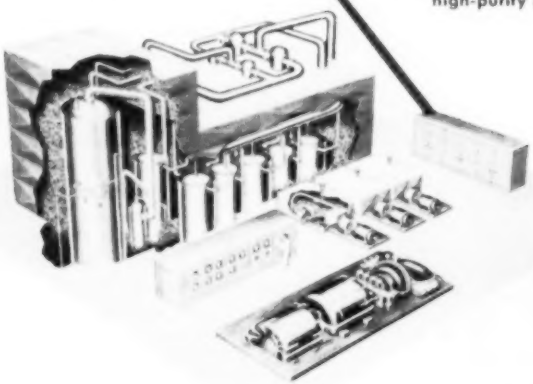

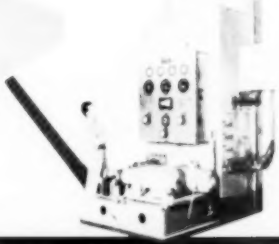

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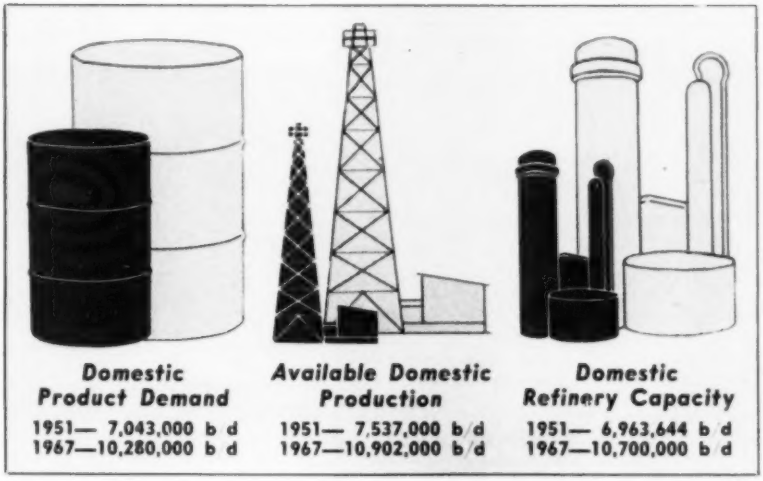


Domestic Product Demand
1951— 7,043,000 b d
1967—10,280,000 b d

Available Domestic Production
1951— 7,537,000 b/d
1967—10,902,000 b/d

Domestic Refinery Capacity
1951— 6,963,644 b/d
1967—10,700,000 b/d

What's Ahead for Petroleum

SUPPLY AND DEMAND—1967

DOMESTIC demand for petroleum products is expected to increase 46% during the next 15 years, and the oil industry to meet that demand probably will spend upwards of $75 billion in expansion and new facilities.

That's the future picture presented to the oil industry this month at the Refining Division session of the 32nd annual meeting of the American Petroleum Institute, in Chicago.

Prepared by John E. Swearingen, general manager of production, and John W. Boatwright, general manager of distribution economics, Standard Oil Co. (Indiana), the forecast reassures the skeptical as to the industry's ability to provide the nation with the oil it needs, and at the same time establishes a foundation upon which to build future industry plans. Highlights of the forecast:

Domestic demand for products will increase from 7,043,000 b d in 1951 to 10,280,000 b d in 1967—a 46% gain.

Production of crude oil and natural gas liquids in the U.S. will be about 9,100,000 b d—about 2,200,000 b d or 33% over present levels.

Imports will gradually increase—from present 900,000 b d to 1,420,000 b d.

Reserve production capacity in the U.S. will be about 1,900,000 b d, or about 21% of actual production in 1967.

Crude runs in 1967 will be at a level of 8,763,000 b d, compared to 6,494,000 b d last year.

New refining capacity will have to be built at the rate of 250,000 b d during the 15-yr. period—to bring total capacity to approximately 10,700,000 b d.

Refinery locations will shift somewhat with respect to crude oil availability—with greater dependence on product pipe lines.

Natural gas liquids will pose one problem for refiners—with output expected to rise from 564,000 b d in 1951 to about 1,065,000 b d.

Exports of products should decline as result of increased foreign refinery expansion.

Although a goodly portion of Mr. Swearingen's part of the forecast deals with production, the editors of PETROLEUM PROCESSING are presenting it in essentially its complete form. We feel that it is the clearest and most complete explanation we have yet seen of why this country is not running out of oil—and that our readers need this information so that they can intelligently talk about the subject to their non-oil friends and neighbors.

Likewise, a large section of Mr. Boatwright's paper deals with economics and the manner in which they affect the petroleum industry. Here again we are presenting essentially the complete paper to our readers—in the belief that even technical men cannot shut themselves up with their slide rules and control valves and let the outside world take care of itself. Our society is cooperative—and each of us must bear his full share of responsibility for determining how it shall operate.

Mr. Swearingen's analysis of our crude supply and forecast for the next 15 years, which we have titled "1967 How Much Oil Will We Have?", begins on the next page. Mr. Boatwright's analysis of demand during that period, which we have titled "1967 How Much Oil Will We Need?", begins on p. 1612.

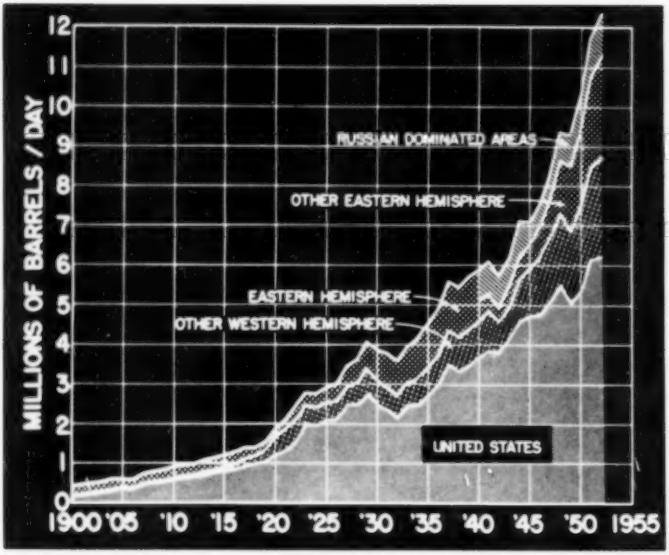


FIG. 1—Production of crude oil, U. S. and world

PART ONE

1967—How Much Oil Will We Have?

Here's your answer to the prediction that we're running out of crude

By JOHN E. SWEARINGEN
General Manager of Production
Standard Oil Co. (Indiana)

FORECASTING the future rate of oil discoveries and availability is fraught with many pitfalls and difficulties. Most forecasts of oil availability have been prepared in the classical fashion of deriving trends of significant variables from historical data and projecting these trends into the future. For several years we attempted to do the same thing, but we have now reached the conclusion that inherent uncertainties in the basic statistics are such as to make any forecast based on them unreliable. It is axiomatic in the producing business that there is a great time lag between expenditures for exploration and the payoff in production. On the other hand, certain general relationships appear to exist between exploratory effort, production and reserves, and these cannot be completely disregarded.

Growth in Production

To provide some background for the problem with which we are dealing, Fig. 1 shows the tremendous growth in U. S. and world crude oil production over the past half-century.

It can be noted from Fig. 1 that, from almost insignificant beginnings at the turn of the century, the rate of crude oil production in the U. S. has grown steadily to more than 6.1 million b/d in 1951. In September of this year the U. S. produced oil at a rate slightly above 6.5 million b/d. The average for the year, of course, will be somewhat less.

World crude oil production now stands at a little over 12 million b/d, with the largest producers in the free world outside the U. S. being Venezuela and the countries of the Middle East. One fact is evident from Fig. 1. The growth in production of crude oil in the past decade has been much more rapid outside the continental U. S. than inside the borders of this country. Even a casual observation of Fig. 1 naturally raises the question: "How long can we continue to produce oil at an expanding rate without becoming dangerously dependent on foreign sources of supply?"

U. S. Crude Oil Reserves

In trying to answer this question, the first thing to examine is the inventory of proved crude oil reserves standing on the books. Fig. 2 shows the estimates of reserves prepared annually by the American Petroleum Institute from 1937 to date. Figures on proved reserves prior to 1937 are not available on a consistent basis. It will be noted that during the past 15 years, our country has more than doubled its proved reserves, not taking

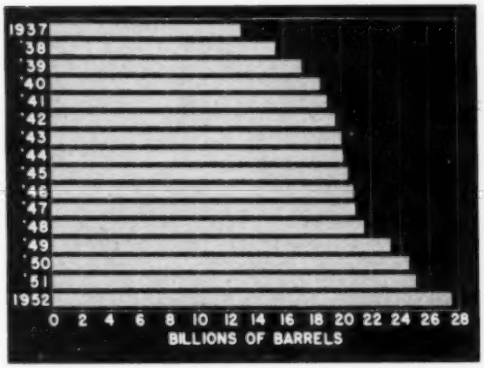


FIG. 2—U. S. crude oil reserves

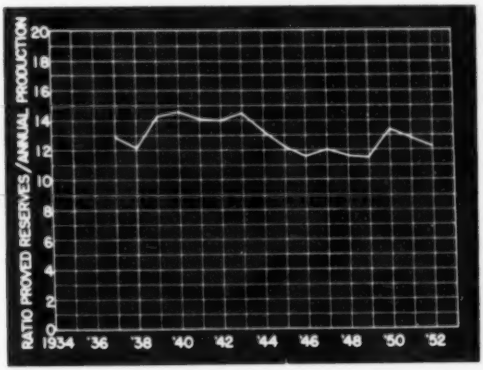


FIG. 3—Ratio of proved crude oil reserves to annual production

into account an additional reserve of 4 billion barrels of natural gas liquids, which adds about 15% more reserve supply. This result has been accomplished while we were producing 24 billion barrels of crude oil. Only during the war years has the industry failed to add substantially to its crude oil reserves. This we attribute principally to lack of steel pipe and skilled manpower during the war to carry on normal activities.

Reserves Vs. Production

Fig. 3 shows the ratio of reserves on Jan. 1 of each year to the annual production in the preceding year. It will be noted that this ratio has varied from a low of about 11.5 in 1949 to a high of about 14.5 in 1940, and currently stands a little above 12. These are the figures which give rise to the claims of many uninformed persons that we are running out of oil; that our present supply will last only another 10, 12 or 14 years. In this connection, there are several things we should like to point out.

In the first place, the reserve figures are proved reserves. Conservative figures on proved area, pay thickness, percentage recovery, etc., are used in making up the estimates. The "probable" or "possible" reserves of new areas may be many times larger than the "proved" reserves, but the "proved" reserves are the ones making up the API figures. History has shown that API proved reserves for fields in the year of discovery are generally only 15 to 25% of the oil ultimately shown to be present.

In the second place, many wells now producing oil will still be producing 50 years or more from now. Even if it were desirable to produce all our oil reserves in a period such as 12 or 13 years, it would be physically impossible to do so.

Third, and most important, any such contention completely overlooks the fact that we are finding more oil every year than we are using, and there is every reason to believe that we shall continue to do so.

Proved Oil Developed Vs. Annual Production

It is more logical to look at our proved crude oil reserves in the manner shown in Fig. 4. Here we have plotted the ratio of proved crude oil developed each year to the then current rate of production. Fig. 4 shows that every year since 1937, with the exception of 1943, we have developed new oil at least equal to our production.

Except for the war years, we have done much better than replace our withdrawals. In fact, over the 15-year period for which data are available, we have developed

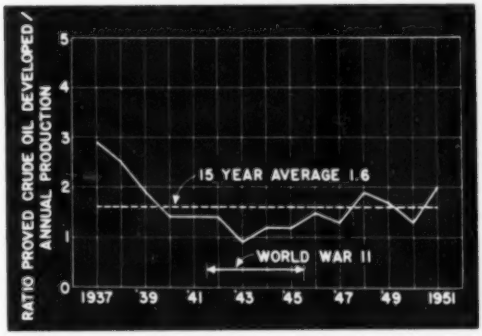


FIG. 4—Ratio of proved oil developed to annual production

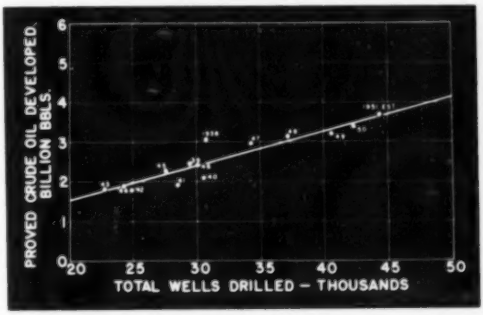


FIG. 5—Proved crude oil developed vs. total wells drilled (3 yr. averages)

1.6 barrels of oil to take the place of every barrel produced. This record certainly does not bear out the contention that we are running out of oil.

Reserve Growth and Drilling Activity

Basically, in order to develop new crude oil reserves, wildcat and development wells must be drilled. Fig. 5 shows the relation between total wells drilled and new

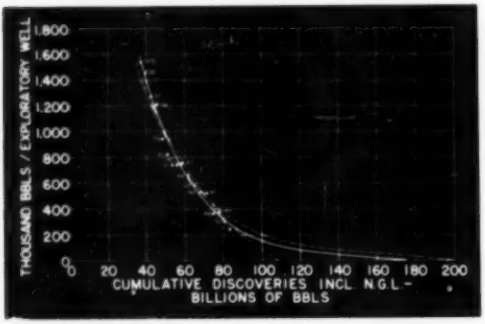


FIG. 6 Discoveries per exploratory well vs. cumulative discoveries

reserves added. We have chosen to prepare Fig. 5 on the basis of 3-year moving averages, rather than on data for individual years.

In years when money and pipe were available, new reserves added were high. During the war years of restricted steel availability, new reserves discovered were appreciably lower. It is only reasonable that this be so.

Fig. 6 is one which many of you have undoubtedly seen before in one form or another. It shows the relation between oil discovered by exploratory drilling and the cumulative amount of oil which has been discovered. Fig. 6 is based on data published every year by H. J. Struth, who takes the new reserves added each year and credits them back to the year of the field's initial discovery, and on F. H. Lahee's exploratory drilling data.

One of the serious difficulties of this procedure is that it gives an unreliable picture of recent discoveries, for the reason that sufficient time has not elapsed to prove up the ultimate reserves attributable to new fields.

Analysis of Struth's data indicates that, after about 8 years, revisions and extensions add almost nothing to the proved reserves of a given reservoir. On the other hand, experience has shown that ultimate reserves of a given field average from four to six times the reserve assigned to it in the year of discovery. We have adjusted Struth's data to recognize this situation.

Fig. 6 shows that in 1935 and 1936 the average exploratory well discovered about 1.5 million bbls. of oil, whereas in 1951 the average exploratory well discovered less than 250 thousand bbls. of oil. Extrapolation of this curve, in an effort to determine the ultimate amount of oil to be produced in the U. S., can easily give any figure between 110 and 200 million bbls. Of course, if Fig. 6 were large enough, we could extend the extrapolation curve beyond 200 million bbls.

Fig. 6 is a very interesting chart, and one dear to the hearts of exponents of the philosophy that we are running out of oil. Basically, it is their argument that oil is becoming harder and harder to find and, even allowing for new discoveries, we shall soon exhaust the available prospects for new oil production.

But we think this conclusion is unsound. In the first place, it is impossible in the year of discovery of any new field to estimate its ultimate production accurately. Even though an attempt is made to correct the basic data to allow for this situation, the correction factors are so large—from four to six times the size of the figures actually reported—that no reliance can truly be placed on the result. And when these extrapolations of actual data are extrapolated themselves, the results are not dependable.

In the second place, the drill is beginning to be used more and more extensively as an exploration tool. Geology and geophysics are invaluable tools for oil exploration, but they have never found one barrel of oil. The drill is the only tool which can do this. Drilling costs have gone up sharply in the past decade, but so have the costs of seismographing and other geophysical operations. In some areas where geophysical methods are unreliable, such as parts of the Edwards plateau country of West Texas, the drill is the only exploration technique which can be employed effectively. We have no doubt that the future will see increasing use of wildcat wells as an exploration tool, particularly so if the industry is able to devise means of reducing drilling costs.

On top of this, we interpret Fig. 6 to show only the trend in discoveries in oil provinces where the industry is now operating. There are large areas of the United States which have never been tapped by the drill, such as the Great Basin of Nevada, much of Arizona and western New Mexico, and large areas in the northern Rocky Mountains, to name but a few. The tidelands are relatively undeveloped, and only 2 years ago one could still say that there was no oil in the 60-million-acre Williston Basin. Even in the known oil country there are some large and favorable areas which have not been adequately explored and drilled. The best of these are large ranches in the lower Gulf Coast and in West Texas. Where enormous ranches are owned in rich oil territory, the present high income-tax rates tend to prevent exploration and postpone possible production to future years. If the landowner's income is so large that he pays most of it to the government in taxes, he is not interested in additional development which will increase income. Some day all of those areas will be drilled.

Basis for This Forecast

In developing this forecast, we have consulted oil-finding people who work in all of the major producing provinces of the U. S., and this forecast represents the consensus of their views. Estimates of future production potentials of the various areas have been cross-checked with one another, and have been revised and adjusted to what we believe to be a mutually consistent basis and one not in conflict with such statistical evidence as can be employed.

For purposes of this study, each of several groups of exploration people was asked to prepare its forecasts on the assumption that a market would be available for all the crude oil which could be produced at maximum efficient rate of production. With MER production rates as estimated, the number of future discoveries and wells necessary to produce at these rates can be derived. After preparation of these estimates, and after the demand rates which Mr. Boatwright will discuss in his paper had been taken into account, it became evident that more oil would probably be available than could be consumed if the fields should be produced at MER rates.

By a successive approximation procedure, it was then possible to estimate reserve producing capacity on a basis consistent with expected rates of production.

As a result of all of these adjustments, this forecast shows a substantial increase in reserve producing capacity over the next 15 years. If we continue in a warlike economy for the next several years, it may be desirable to provide this reserve producing capacity. If, on the other hand, conditions change so that this extra capacity is not needed, the exploration and drilling programs of the industry will probably be curtailed, and will thus postpone the finding and development of some of the producing capacity forecast in this study.

In considering these predictions, it should be kept in mind that geologists in the U. S. and Canada have been very successful in finding new oil fields during the past

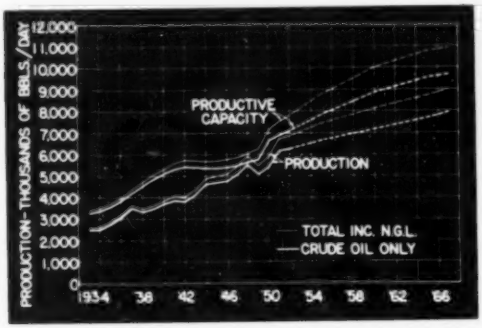


FIG. 7. U. S. productive capacity and production, estimated to 1967

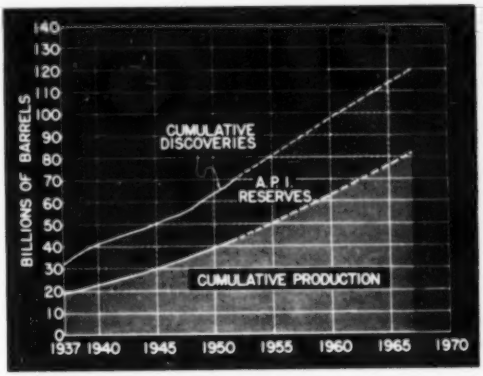


FIG. 8. Cumulative U. S. crude oil production and discoveries

two or three years and are, therefore, optimistic about their continued ability to find oil.

In the past few years the reef fields of West Texas have been developed, and have come into production. Development of the Spraberry sand in West Texas has been commenced; important new reserves have been found on the flanks of the salt domes along the Gulf Coast; large new fields have been found in the prairie provinces of Canada; new oil has been discovered in western Nebraska, eastern Colorado, and Utah; and, perhaps most important of all, a major new oil province has been opened in the Williston Basin.

Had the present forecast been made 4 or 5 years ago, it might not have been so optimistic, and it is possible that a similar forecast 5 years from now might be more pessimistic. But, notwithstanding this inherent question of accuracy, the oil finders' appraisal of their future hunting ground is better than any outsider could possibly make.

The present forecast of supplies includes a considerable amount of oil attributed to secondary recovery by water-drive and gas-drive methods, but assumes no drastic change in these practices. The forecast contains no production which may ultimately be developed as a result of new secondary-recovery methods not yet perfected in field practice.

Production and Availability

Our forecast of production of crude oil and natural gas liquids in the U. S. for the next 15 years is shown in Figure 7, together with our estimate of the nation's productive capacity. Several things are noteworthy about Fig. 7. First, we feel that domestic production of crude oil will continue to increase over the period we have considered and, second, that the industry will be building up its producing capacity faster than production; in other words, we shall be finding oil faster than we shall be using it.

We estimate that the industry in 1967 will be producing about 8 million b/d of crude oil and 1.1 million b/d of natural gas liquids—a total of about 9.1 million b/d. This is an increase of about 2.2 million b/d over present levels, or about 33%. Natural gas liquids are expected to become an increasingly important part of our supply picture as gas sales increase and pressure-maintenance projects come into more general use for increasing ultimate crude oil recovery.

It will be noted that the nation's productive capacity has appreciably exceeded actual production except during the years immediately following the war, when release of the pent-up demand severely taxed the industry's capacity. At present we have reserve producing capacity of about 900 thousand b/d. Our forecast expects this reserve capacity to increase to about 1.9 million b/d in 1967, or about 21% of the daily rate of production at that time.

In summary of Fig. 7, it is our conclusion that the domestic oil industry will find enough oil in the next 15 years to meet foreseeable demand and, barring a major war with virtually complete cessation of imports, the industry will have a comfortable margin of producing capacity in excess of actual requirements.

In order to reach a producing capacity of the magnitude shown in Fig. 7, the oil industry of the U. S. must find and develop approximately 49 billion barrels of crude oil between Jan. 1, 1952, and the end of 1967. As indicated in Figure 8, this task should be measured by the industry's production, from its beginning to date, of approximately 42 billion bbls. and total discoveries to date (production plus reserves) of about 71 billion bbls. Our forecast indicates that, by the end of 1967, cumulative crude oil discoveries should reach 120 billion bbls., with proved reserves standing at 38 billion bbls.—about 13 times the then current rate of production.

If this task seems large, let us point out that, during the past 15 years (as shown in Fig. 8), the industry has added 39 billion bbls. as compared with 49 billion forecast for the next 15 years.

In order to discover and develop these reserves, a substantial, although gradual, increase in drilling effort will be required. Although we have forecast a sizable increase in exploratory drilling, the number of field development wells required will be not appreciably larger than at present. The total number of wells forecasted for 1967, 62,000, appears to be easily within the reach of the industry.

Sources of Oil in the Future

Interesting, of course, will be the source of all this oil of the future. Figure 9 shows the various PAW Districts of the U. S. with 1951 and estimated 1967 production of crude oil and natural gas liquids indicated for each district.

PAW District I covers the eastern section of the U. S. In this area the only states now producing oil are New York, Pennsylvania, W. Virginia and Florida. We are forecasting that this area will increase in production from about 69,000 b/d in 1951 to about 115,000 b/d in 1967. We expect that the major part of this new oil will come from Florida, and that the old producing areas of New York, Pennsylvania and W. Virginia will continue their gradual decline.

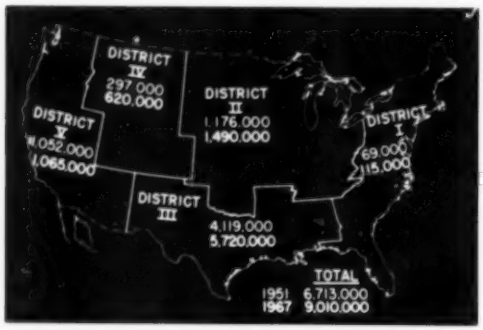


FIG. 9—Production of crude oil and natural gas liquids in b/d, 1951 and 1967, by PAW Districts

PAW District II covers principally the Mid-Continent area. We are estimating that production in this area will increase from 1,176,000 b/d in 1951 to about 1,490,000 b/d in 1967. The major portion of this increase should come from N. Dakota and S. Dakota, for which states we are forecasting production at a rate of about 316,000 b/d in 1967.

PAW District III includes states bordering the Gulf Coast from Alabama to Texas, plus Arkansas and New Mexico. We are estimating that production in this area will increase from 4,119,000 b/d in 1951 to 5,720,000 b/d in 1967. We expect Louisiana alone to increase from about 697,000 b/d to about 1,180,000 b/d, with about 290,000 b/d coming from offshore properties, as compared with about 19,000 b/d last year. We expect to see Mississippi double its production to about 209,000 b/d. We expect to see the Texas offshore fields producing some 68,000 b/d 15 years from now. We anticipate substantial increases in production along the Texas Gulf Coast—from about 1,050,000 b/d to 1,530,000 b/d—and almost as much from the prolific Permian Basin of West Texas.

The large thick sands encountered along the Gulf Coast pinch out on the flanks of most of the known salt domes. Exploration in this region in recent years has shown production from such pinch-out sands to be very prolific, and we anticipate substantial increases in production from this source in the future. Recent years, in West Texas, have seen discovery of the great reef fields of the eastern shelf, and there is every reason to believe that substantial accumulations of oil can be found in the Pennsylvanian rocks along the edge of the Central Basin uplift. Another significant development in recent years has been the discovery of Ellenberger production in the middle of the Permian Basin. Pegasus, Benedum, and Midland Farms are examples of such fields. There will be many more.

PAW District IV, which covers the Rocky Mountain area, is forecast as increasing in production from 297,000 b/d in 1951 to 619,000 b/d in 1967. We expect the Montana portion of the Williston Basin to grow to about 180,000 b/d, and Wyoming's production to expand a little more than 100,000 b/d.

In PAW District V, which covers the West Coast, we expect the present rate of production of 1,052,000 b/d to be maintained at essentially present levels throughout the forecast period. Production onshore in California will probably decline, but this should be offset by development of the California tidelands. Our figures do not include any production from the Elk Hills Naval Reserve, which is a major reservoir, but which probably will not be produced unless we get into an all-out war.

Although we have made no detailed forecast of the quality of crude oil which will be available in future years, there is some basis for belief that a higher proportion of low-sulfur crude will be available than has been the case in the recent past. Crude oil from the Williston Basin, from the offshore areas of Texas and Louisiana, and from the deep pays of the Permian Basin, by and large is low in sulfur content. These are the areas which should produce most of the additional oil which will be needed over the next 15 years.

Natural Gas Liquids Availability

The preceding discussion has been concerned principally with availability of crude oil, but recent years have seen a dramatic increase in recovery of liquids from natural gas.

Gasoline plant capacity in the country has expanded enormously in recent years due to the emergence of repressuring as a common tool for increasing recovery of oil from known reservoirs. The use of such facilities will undoubtedly expand.

We expect to see more natural gas liquids extraction plants installed along the large interstate gas pipe lines to recover propane, butane and heavier materials from gas streams intended for industrial or residential consumption.

The industry's development of salt cavity storage will provide badly needed facilities for storing LPG during slack demand periods for later recovery and marketing during periods of high demand.

We are forecasting that production of natural gas liquids will rise from 564,000 b/d in 1951 to about 1,065,000 b/d in 1967. The larger proportion of volatile liquids available may necessitate some changes in refining operations, but growth will be gradual, and adjustments to use of this raw material will be made over a period of time.

Other Prospects for Additional Oil

If it should develop that the industry is unable to find oil by historic methods at the rates predicted in this forecast, we still have several other strings to our bow.

Present methods of oil production, on the average, recover 25 to 35% of the oil in place in the ground. In fields where a natural water drive is present, such as East Texas, recoveries may ultimately be as high as 80% of the oil originally in place. In pools where a natural water drive is not present but where water injection can be practiced, recoveries can frequently be increased from 25 to 35% to the range of 40 to 60% of the oil in place.

If technologists of the industry can devise means of substantially improving present recovery practices, we can add many billions of barrels to our known reserves at no finding cost, and can push even farther into the future the day when this country will be deficient in its oil supplies. This problem is being studied, and some of the ideas now in the laboratory or yet to be discovered may prove practical for field application.

The figures of our forecast assume a normal increase in water flooding, gas injection and other conventional methods of secondary recovery, but they do not recognize the possibility of any increased production through application of techniques not now in commercial use.

There is a much larger area of this country which is potential oil territory than is being produced today. Naturally, the oil industry has explored for oil fields in those territories which appear to have the best production prospects.

But it should be pointed out that the large areas of the Williston Basin of the Dakotas and Montana, and

the Uintah Basin of Utah and Colorado, had no oil production five years ago. They are now being actively explored and developed, and their producing areas will be enlarged still more. Any day one of these other prospective areas, such as the Great Basin in Nevada and Utah, southeastern Colorado, the Salina Basin in Kansas and Nebraska, or any of several others, could break into the producing column.

Improved techniques of seismograph and other geophysical methods, together with improvements in drilling practices, which would lower the cost of digging wells, could do much to extend the present producing area and productive capacity of this country.

Oil Outside the United States

This paper is primarily concerned with the availability of oil from domestic production for U. S. refineries, but any such discussion would not be complete without some comment on the foreign oil situation. At present, reserves of oil and natural-gas liquids in the U. S. stand at some 32 billion bbls., as compared with some 74 billion bbls. for the rest of the free world; 52 billion bbls. of these reserves are located in the Middle East; most of the balance is located in Venezuela and other South American countries.

At present the U. S. is importing a little more than 900,000 b/d of crude oil and refined products. If production capacity of this country increases at the rates set out in this forecast, we expect to see a gradual increase in imports to about 1,420,000 b/d in 1967.

By and large, we expect most of the foreign crude brought into this country to be processed in refineries along the East Coast. Although we expect Canadian crude oil production to increase from about 132,000 b/d in 1951 to 715,000 b/d in 1967, we anticipate that imports of Canadian crude will be primarily for use in the Pacific Northwest and the area around the head of the Great Lakes.

Our estimates of foreign crude oil production capacity indicate that there will be substantially more crude available to us than we shall probably permit to enter this country. As is well-known, importation of crude oil is a matter subject to governmental regulation, and governmental regulation is a field in which forecasting is more of a guess than a science.

Conclusion

There is one final factor in considering the future supply of oil for the U. S. In Fig. 10 we have shown a comparison between gross income received from crude-oil sales and total expenditures for drilling oil wells.

It will be noted that there is a direct correlation between money available to the oil industry and money spent for drilling wells. The line in Fig. 10 indicates that the industry spends a little more than 40% of its gross income for drilling. Although no precise figures are available, a roughly equivalent amount goes into exploration and leasing, and the balance goes into taxes, overhead, profit and general expenses.

The correlation is excellent, except during the years 1944, 1945 and 1946, when the industry continued to spend more than normal amounts of money for wells even though the price of crude oil was frozen at an unduly low level.

Now, as to the significance of Fig. 10, it indicates that drilling activity is related directly to industry income. If the oil producing industry is to achieve the levels of production predicted in this forecast, it must have the money to do the exploration and development.

If the government takes a bigger tax bite; if the depletion allowance is reduced or done away with; or if arbitrary and costly regulations are imposed to restrict

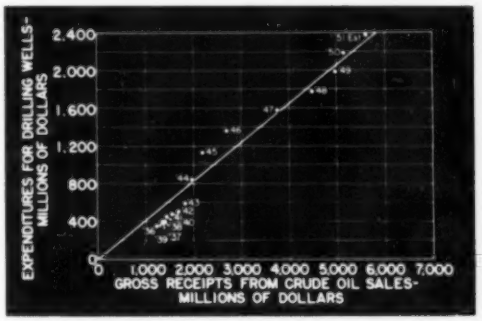


FIG. 10—Gross receipts from crude oil sales vs. expenditures for drilling wells (3-yr. averages)

freedom of activity, each will have a direct bearing on the industry's ability to find new oil.

If the price of crude oil is fixed while drilling costs are permitted to rise, the total number of wells which can be drilled must necessarily be reduced.

At this point we should like to remind you that drilling costs, because of inflation, increasing depth, etc., have increased almost fivefold during the past 15 years; that they have increased substantially since the war; and that crude-oil prices have remained unchanged since 1947.

It is our firm conviction that the domestic oil industry can supply sufficient oil to meet all of our needs for the foreseeable future; but, no matter whether the industry can do these things, the result will not be achieved unless the industry is permitted the freedom to do the job which has to be done.

Meet the Author

John E. Swearingen is co-author with John W. Boatwright of this paper on the future availability of petroleum.

He was born in Columbia, S. C., in 1918, and is a graduate of the University of S. Carolina in chemical engineering. He received an M.S. degree from MIT in 1939, after which he joined Standard Oil Co. (Indiana) as a chemical engineer in the research laboratories at Whiting, Ind.

In 1947 he was transferred to the manufacturing department of the subsidiary, Stanolind Oil and Gas Co. at Tulsa. In 1949 he became assistant to the vice president in charge of operations, and in 1950 was made manager of the company's central division at Oklahoma City.

He was transferred to Chicago in 1951 to become general manager of production and, in 1952, was elected to the board of directors—the youngest executive ever elected to Indiana Standard's board.

Mr. Swearingen is a member of the American Petroleum Institute, AIMME, and several other professional and technical societies.

PART TWO

1967—How Much Oil Will We Need?

Domestic demand for petroleum products will rise 46%—to 10,280,000 b/d

By JOHN W. BOATWRIGHT
General Manager of Distribution Economics
Standard Oil Co. (Indiana)

THIS forecast of petroleum demand has been made giving recognition to the nation's total output of goods and services. No attempt was made to time a business recession or recessions, although this possibility was clearly recognized. In reviewing a 15-year time period, we believe the basic growth factors of the economy to be more significant than annual deviations which may occur about that growth curve.

The anticipated growth of population, expansion of industrial production, capital investment in new plants and durable equipment, employment level and other underlying basic economic trends were studied. Individual uses of petroleum were analyzed against that background. Total energy needs and the shifting proportion of the total supplied by petroleum, transportation requirements represented by number of units and consumption per unit, radiation units installed and requirements per annum, and industrial processing with petroleum products were analyzed from historical data and probable future needs. Agricultural and other off-the-highway needs for gasoline and other petroleum products were studied.

All in all, several hundred indices of change were analyzed to the best of our ability in order to ascertain the probable future needs for petroleum products. The composite results of these separate studies are shown in Table 1, and are as follows:

1. Total domestic demand for petroleum products is forecast to increase from 7,043,000 to 10,280,000 b/d by 1967, or a 46% gain. Exports should decline as a result of increased refinery capacity built in foreign lands. Reflecting the influence of this decline in exports, total demand for all products should increase from 7,166,000 to 10,400,000 b/d, or an increase of 39%.

2. The forecast of domestic demand for gasoline, representing a 46% expansion, reflects our guess of growing military needs, as well as the increased requirements for civilian uses. Incidentally, the growth in gasoline requirements would have been higher had it not been for the competition we anticipate from the use of liquefied petroleum gas by trucks, tractors, buses, etc.

3. The increase of 44% for kerosine and distillates reflects the growth of jet fuel utilization, continued trend to dieselization, growth of present uses, and new uses for the product.

4. The forecast of demand for residual fuel represents the smallest increase of any of the product classifications. Utilization of this product, by types of industries, presents contrasting trends—some increasing and some declining. Probably the most significant industry trend recognized was that oil-fired steam locomotives would be almost entirely converted to diesel fuel considerably prior to 1967.

5. The most significant increase forecast applies to "other products," including lubricating oils, asphalts, waxes, petroleum chemicals, coke, still gas, and liquefied petroleum gas. The sizable increase in volume of LPG, representing a gain of 175%, explains the major proportion of growth anticipated for this class of products.

Table 1—U. S. Total Demand

(Figures in Thousands of Barrels Per Day)

Domestic	1951	1955	1960	1965	1967	Increase 1967 over 1951 (per cent)
Gasoline	2,987	3,343	3,910	4,250	4,350	46
Kerosine and distillate fuel	1,569	1,909	2,064	2,210	2,260	44
Residual fuel	1,344	1,648	1,716	1,825	1,860	38
Other products	943	1,238	1,490	1,722	1,810	92
Total domestic demand, all products	7,043	8,138	9,180	9,990	10,280	46
Total exports	123	185	125	120	120	-72
Total demand, all products	7,166	8,463	9,305	10,110	10,400	39

The Adequacy of Supplies

Now let us turn to a comparison of demand with estimated supplies of crude oil and natural gas liquids. This comparison is offered on two bases so that the individual reader may draw his own conclusions depending on his degree of conservatism.

It will be noted from the comparison in Table 2 that purely domestic supplies will be adequate to meet total needs without imports, and will still afford the nation a protective cushion of about 5%. But this comparison is unrealistic to the extent that there will be imports of both crude and products. Striking a comparison on this basis, we arrive at Table 3.

Now it will be noted that the protective cushion ranges up to 2 million b/d, amounting to between 18 and 20% over requirements. The Petroleum Administration for Defense is now advocating for security reasons that reserve producing capacity be pushed to about 25% above total domestic demand, including imports. We do not feel that this level can be achieved without some major adjustments to the industry's drilling program. In fact, we doubt that the industry will be able to carry a margin of greater than approximately 20% over current demand.

There has been considerable study of production of synthetic fuels to supplement the availability of crude oil. Repeated study and analysis of this problem is healthy. To advocate building a synthetic industry, however, is to select the synthetic route as preferable to the traditional means of increasing supplies. This is a decision which should be based on economic considerations.

We do not wish to enter into, or to discuss differences in, reports by committees, consultants, or the Bureau of Mines on this subject. But isn't the answer relatively clear?

Men in petroleum are well-acquainted with synthetic

fuel production processes. Petroleum capital will build such plants as soon as the conviction has been reached that production of synthetic fuels affords a more attractive return on investment than alternate use of that capital in customary development. Thus economic considerations will determine when synthetic plants will, and should, be built.

When may such economic conditions indicate that synthetic production may be anticipated? No one knows. In terms of total supply, there appears to be a healthy cushion of sufficient magnitude for the next 15 years so that any construction as of this date would be at tremendous social cost.

Also, it should not be forgotten that our estimates of future availability of crude oil and natural gas liquids reflect economic pressures for increased supplies. If the government builds plants for producing synthetic fuels from shale, coal or gas, and thus competes with industry, this tends to reduce the private search for oil supplies from natural resources. If such plants are operated in competition with private industry and do not make money, then the total availability of oil is less than it would have been if the same amount of money had been spent for direct exploration. If these plants are not operated because they cannot operate at a profit, wastes are compounded to ridiculous amounts.

And, to repeat, if they can be operated at a profit comparable with that earned from other sources of oil, oil men will build them.

Probable Crude Runs and Refinery Capacity

Total requirements of petroleum products will be supplied from several different sources. Imports of finished products, particularly heavy fuels, will continue to supply an important part of demand. Transfers from crude and natural gas liquids will also supply an important segment of the total. After making these and other minor adjustments—such as losses, crude exports, and refined-product inventory changes—we find that the probable crude runs by years will be as indicated in Table 4.

Let us assume that the ratio of crude runs to total capacity in 1967 will be approximately the levels maintained during recent years. This gives us a clue to the probable refining capacity of the industry. On this basis, total refinery capacity in the nation will be approximately 10,700,000 b/d. This will require an annual expansion of total refinery capacity of approximately 250,000 b/d.

Certainly this presents no unusual challenge to the industry in the light of what it has achieved since 1946—our average building rate per annum from 1946 through 1951 having been 320,000 b/d. And, when we think of total refinery building, we must recognize that the industry will have to replace obsolete equipment as well as add new capacity.

Estimated expenditures by refineries alone in 1952 will probably exceed one billion dollars. There is no question that the industry will provide adequate refining capacity to meet market needs.

In connection with constructing new refineries, some interesting new development will unquestionably be evidenced. Factors determining the economics of refinery location are changing.

Technological progress of fuel reduction is resulting in higher yields of light products susceptible to pipe line movement and in lower yields of residual fuels not susceptible to low-cost transport movement. This changed pattern of yields, and the ICC limitation on earnings on crude oil pipe line investment to 8%, and the permissible rate of earnings of 10% on product pipe lines, are important factors in determining the location of a new refinery.

Inasmuch as new crude producing areas must be connected to future markets, there are sound reasons for anticipating a greater dispersal of refineries—and this offers the advantage of decentralization of military targets, a greater dependence upon product pipe lines, and a reduced relative dependence upon crude oil pipe lines.

Table 2—Domestic Availability Vs. Total Demand

(Figures in Thousands of Barrels Per Day)

	Domestic Availability of Crude Oil and Natural Gas Liquids	Total Demand, Including Exports	Margin of Domestic Supply Over Total Demand
1950	7,125	6,812	313
1951	7,537	7,467	70
1955	8,792	8,465	327
1960	10,016	9,305	711
1965	10,738	10,110	628
1967	10,902	10,400	502

Table 3—Total Availability Vs. Total Demand

(Figures in Thousands of Barrels Per Day)

	Total Estimated Supplies of Crude Oil and Natural Gas Liquids from Domestic Production, Plus Imports	Total Demand, Including Exports Minus Imports of Finished Products	Estimated Margin of Total Supply Over Total Demand
1950	7,615	6,449	1,161
1951	8,025	7,111	914
1955	9,492	8,123	1,369
1960	10,580	8,978	1,602
1965	11,692	9,677	2,015
1967	11,852	9,933	1,919

Table 4—Estimated Crude Runs Required

(Figures in Thousands of Barrels Per Day)

1950	5,739
1951	6,494
1955	7,253
1960	7,878
1965	8,503
1967	8,763

Transportation Requirements

Increased quantities of crude oil and natural gas liquids must be brought to the refinery, and the finished products must be moved from the refinery to the market. This means that transportation facilities will be expanded. Crude oil pipe lines will be built from new sources of crude to present refinery centers, and to new refinery centers; whereas new product pipe lines will be built from new refinery centers into markets which are presently served by pipe lines, and into markets which are not today considered sufficiently concentrated to warrant expenditures for such facilities.

Approached purely on a statistical basis, it would appear that crude oil and products trunk-line traffic will increase by some 400 billion barrel-miles. This means that between now and 1967 the industry will build a net increase to its present pipe line system equal to approximately half its present carrying capacity.

Another substantial consideration which needs to be recognized in the transportation factor is that the carrying capacity of ocean tankers will have to be increased. Adjustments of the carrying capacity of barges, tank cars, and truck transports will be made on a regular annual basis as may be needed by the market.

Thus our review of the probable 15-year future leads us to certain basic conclusions.

1. We feel confident that the future supply of crude oil and natural gas liquids will be adequate to meet the needs of a greatly expanded market. Nevertheless, we also feel that the demand for a larger backlog of producing capacity will result in greater and greater exploratory effort.

2. Even though many have considered that the postwar refinery building programs were of a catching-up nature, it now appears that building at almost the average rate achieved since 1946 will be normal expectancy for the future.

3. Adjustments, changes and constant expansion of

transportation facilities will be needed in the future.

Our analysis gives us confidence that the industry should be able to continue to do the job which it has always achieved, viz., supplying all the oil needed. "Growth" is perhaps the one word which best characterizes the future of our industry.

A Few Major Economic Considerations

In the conduct of our study we encountered many economic uncertainties which had to be resolved by assumptions. The validity of our forecasts depends upon the accuracy of our judgments. We believe that you will be interested in these problems and in our conclusions regarding them. If subsequent events prove to be different from what we have concluded, then our prognostications would have to be changed.

Monetary Stability

We have assumed a greater degree of monetary stability than has been in evidence in the past 5 years. This is an essential requirement to the accomplishment of the objectives previously discussed. We do not desire to discuss the effects of inflation or deflation on future industry growth. However, attention should be called to the fact that we are now in that phase of economic evolution when confiscation of property is reaching into investment in capital tools. Perhaps we can best state it in this language:

a—Depreciation allowances for profit determination for income tax purposes are inadequate to replace capital tools now in use.

b—The understatement of depreciation results automatically in a corresponding overstatement of reported earnings.

c—Reported earnings are subject to graduated income tax payments.

Hence we are actually paying an income tax every year on a part of the capital invested in fixed plant facilities. Therefore, we are in a period of capital tools confiscation.

Obviously expansion cannot be built soundly upon such a foundation. If this industry and other industries in this country are to achieve the growth needed to meet the requirements of a greater population and defense objectives, it will be necessary that a certain stability of the purchasing power of the dollar be achieved.

Financial Requirements

Most people look at an industry facing a substantial market expansion with considerable optimism. This is as it should be, but there is a problem which must be recognized. We, in petroleum, realize that frequently our expansion capital must be expended from 2 to probably 6 years ahead of the period of actual need. Petroleum is a heavy capital-requirement industry. Its cash is frequently drained off to provide expansion required in the future.

Very few people, either in or outside the industry, realize the magnitude of capital requirements which will have to be met to build for a future market of the size discussed. No one knows what the actual total investment will be. The best anyone can do is to approximate. Our approximations resulted in a staggering concept of future capital requirements.

We believe that total future expenditures for exploration and development of necessary reserves, for transportation facilities, and for refining and distribution needs will average approximately five billion dollars per year. In fact, we are looking at a 75-billion-dollar program. This estimate is based upon the 1952 purchasing power of the dollar. If inflation continues, the amount will be correspondingly increased.

We have assumed that the industry would finance this growth, but it cannot be financed from reserves and retained earnings. However, we believe it well for all members of the industry to recognize that financing industry expansion is one of our greatest future responsibilities. We feel that it is even more vital that people outside the industry appreciate the essentiality of the profit incentive, as well as the inescapable necessity of plowing back a part of earnings, if we are to continue to grow.

Price Freedom

What assumption should we make about future price regulation? We recognized that most of our historical pattern had been established when the economy was not subject to governmental price ceilings. We know also that prolonged price regulation leads to rigidities in an economy, and this inevitably retards growth. Hence we assumed that present price regulations as applicable to petroleum would not prevail for much of the 15 years under review.

This appears to be a logical assumption, because:

a—Supplies are considerably in excess of present rate of consumption.

b—Supplies are susceptible to substantial expansion both from domestic and foreign sources.

c—The geographical distribution of supplies and the production rate of particular products are often adversely affected by insensitive price ceilings.

d—Price ceilings do not recognize growth requirements.

e—A vast proportion of petroleum is now being sold at less than ceiling prices.

f—The potentiality of increased foreign competition is ever-present.

In fact, we don't see why price controls on petroleum could not be removed right now.

Highway Limitations

The data we have projected on cars in use and consumption per car cannot be achieved on the basis of present highway capacity. This economy is built to a large extent on an unusual degree of freedom of movement and transport via highways. We are convinced that many new highways must be built; many of the present ones will have to be improved and modernized. Estimated expenditures for highway construction in 1953 range between 2.7 and 3 billion dollars.

We feel that such new transportation arteries as are constructed will have to be engineered with the same degree of skill and planning as that applied to private ventures. In fact, both the petroleum and automotive industries may find it desirable to establish a group of expert highway engineers to function in an advisory capacity to insure efficiency of highway planning, construction, and financing.

The American public will pay a fair cost for making these additional facilities available. This is adequately demonstrated by the financial success of turnpikes. Therefore, as a basic premise underlying our work, we have assumed that funds made available for highway construction will be used almost exclusively for that purpose, and that they will be wisely expended.

Industry Know-How

Money alone will not insure the growth needed. Money must be associated with industry problem-solving know-how. This presents a two-horned dilemma: a—broadening the training of more promising young men who will have to supervise the wider investments incident to a growth industry; and b—retaining the productivity of some of our most successful industry members after the tax laws of the country have eliminated the economic incentive for further work.

The assumption regarding the first of these two was easy to reach. Larger capital requirements will necessi-

tate careful supervision. This means that present management will have to train a larger number of leaders to follow them. It seemed a logical conclusion that many companies in the industry would select their more promising young men and shift them from position to position so as to provide them with the broad basis of training necessary to meet the leadership requirements of the future.

The second part of this problem is more difficult. Why should a skilled individual continue to strive for greater accomplishments when he is denied the fruits of his labor by tax laws? And yet we know that our economy must have the benefit of the productivity of this class. Hence we have assumed the continued active contribution of the most successful persons of our industry, even though we appreciate that their present economic incentives are grossly inadequate.

Labor Relations

Management-labor relationships in our industry have traditionally been on a local or, at the widest, on a company basis. This has been conducive to progress, as evidenced by wages paid and employe benefits received as fine as are enjoyed in any industry. But efforts have been made to substitute bargaining on an industrywide basis. When industrywide negotiations come into existence, there is an ability to extort something from the public, whether this ability is exercised or not. Interruptions of operations because of labor-management disagreement when on an industrywide basis are in fact actions against the public.

There are competitive advantages incident to good labor-management relationships. Many in this industry are most anxious to see these advantages preserved both for labor and management. For this reason, we assumed that the general pattern of labor relationship would not change.

Divorcement

Competition in the market over a period of many years has built an industry structure designed to meet best the needs of the market. In many cases individual firms have worked toward an integrated pattern for the purpose of supplementing the market organizational function of competition. This has resulted in various degrees of integration on the part of the vast majority of firms engaged in the petroleum industry.

We recognize that many organizations feel that the controversy involving integration does not touch them, but it does—either through ownership of transportation facilities, ownership of retail outlets, or ownership of an interest in more than one phase of the industry.

There is a suit now pending which seeks to force a segregation of marketing from other phases of the industry. None of us knows how far this effort will go. We are confident that it is an effort to modify a structure which has been built as a result of competition in the industry. It pleads that additional curbs, or barriers, to the free flow of capital and effort be introduced with respect to the petroleum industry. Therefore, if atomization of this industry results from either judicial or legislative action, the forecast which has been presented is no longer valid. A chaotic condition not subject to the same economic laws which have existed in the past will be brought into being, and the premises upon which the forecasts were based no longer exist.

Reward to Capital

This is an extremely complex subject to attempt to cover in a few paragraphs. Normally, we think of the claimants upon a productive capacity of an economy as being labor, capital, government and consumers. Labor receives a wage for its hire; capital receives an interest or dividend; the government receives its portion through taxes, and the consumer should receive his portion through greater real purchasing power of the dollar because of lower prices.

But all laborers and all providers of capital are also consumers. Therefore, it is difficult to segregate the consumer's share of the output of goods and services. In reality, if we recognize this overlapping, we could say that the claimants are but three, viz., labor, capital owners and government.

Of these, government has received the greatest rate of increase through higher and higher taxes. Labor has received an increasing proportion of gross national production. The providers of capital have received a diminishing proportion.

We have already seen the essentiality of tremendous capital outlays on the part of this industry. To achieve this growth is to the benefit of labor, government and the providers of capital. A more equitable sharing of the fruits of production is a prerequisite to continued growth. We believe that rewards to capital have passed the low level, and that the future will see increased interest rates.

Hence we have assumed that the capital-supplying segment of our society will be more adequately compensated in the future, and that a more well-balanced participation in gross national production among capital, labor, and government will come into being. It must, if the forecasts are to be realized.

Conclusion

As to this forecast, we feel that there must be a word of caution. The industry alone cannot insure accomplishment of these objectives. If the American people will create an environment characterized by monetary stability, free prices, intelligent labor relationships and a sound highway-development program, this industry will supply the petroleum needed to meet full requirements.

Meet the Author

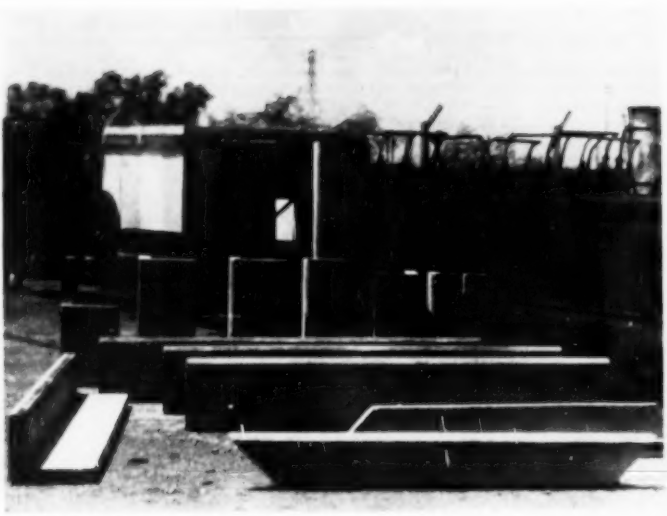
John W. Boatright is co-author with John E. Swearingen of this paper on the future availability of petroleum.

He was born in Lancaster, Kans., in 1903, and received a B. A. degree from William Jewell College, Liberty, Mo., an M.A. degree from American University, Washington, and his Ph.D. from Northwestern University.

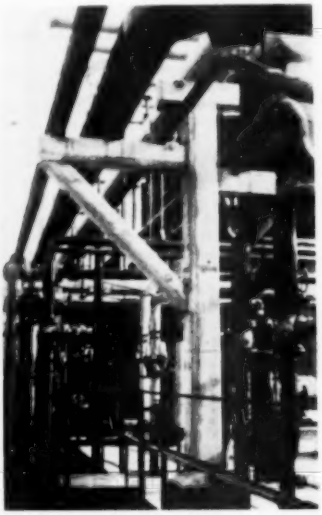
He joined Standard Oil Co. (Indiana) in 1932 as an economist in the sales research department, and in 1938 became head of the sales research department.

In 1947 he was appointed general manager of the distribution economics department, his present post. In this position he is responsible for all functions relating to sales budgets, general economics studies, product supply problems, consumer research studies, economic evaluation studies, and profit and loss analyses.

During World War II Mr. Boatwright served on several PIWC committees. He is a member of the API Statistical Advisory Committee, serves on the Advisory Committee to the Bureau of the Census, and during the first half of last year served as a consultant to PAD.



READY TO INSTALL, lightweight, pre-cast sections of concrete fire protection, cut to dimension



AS INSTALLED on a steel pipe support (darker areas are mortared joints)

"PRE-FABS" PERMIT GOOD

Savings in Structural Fireproofing

By C. J. KUHASZ
*M. W. Kellogg Co.**

INSTALLED cost of fireproofing structures can be reduced substantially by a new method consisting essentially of using shop-fabricated sections of a lightweight concrete.

As used in a number of refinery projects both those now in operation and others currently under construction the cost has been cut 25 to 50% under that of conventional methods of fireproofing.

The method, developed during an investigation in 1949, produces a protection with fire resistance of at least four hours under tests conducted in accordance with ASTM procedures. The pre-fabricated sections of concrete are made in two standard shapes, 90° ells and flats, designed for boxed-in or for contour type of fireproofing, and are shown in the illustration above. The sections are cast to predetermined dimensions in adjustable metal pans from a mixture of perlite aggregate and air-entrained portland cement. Prior to casting, consideration is given to shrinkage and erection tolerances.

The sections are suitably reinforced with welded wire mesh and all corners exposed to weather are chamfered at a 45° angle. In addition: 1) a metal joint bar is embedded along one edge in certain sections, 2) all corners facing an adjacent section when installed are formed to provide a V-joint between the sections, and 3) all weathering surfaces are provided with a steel-troweled smooth surface.

Sections are removed from the pans as soon as concrete has set, and then are stored on racks where they are properly cured. Prior to shipment to job site, each section is drilled with a standard arrangement of shoulder holes for attachment to the structural members.

At job site, the sections are secured to the structural profiles to be protected by using threaded welding studs of single length. The studs are welded to the steel surface by inserting them into the holes provided in the sections, after which a steel adapter ferrule is inserted in the holes over each stud, and the nut is then tightened on the stud. The adapter prevents shearing of the concrete shoulder in the hole.

Studs are also inserted in the holes along the edge of the section and welded to the joint bar. Adapters are then inserted and nuts pulled up until the joint between sections is tightly closed.

After all studs are installed, the space above them is packed with perlite mortar for protection, and finally the V-joints between sections are sealed by filling with mortar. Where structural profiles are boxed-in, the void can be filled with a low ratio cement-to-perlite mixture or left empty depending upon plant requirements. Sections used on structures exposed to weather should be given a coat of water-proofing paint. Sections used indoors in general require no painting, as they are furnished with a very smooth finish and almost white in color.

Some of the economic advantages gained by use of the pre-fab method over either sprayed-on or poured-in-place, regular heavyweight concrete are the result of lightweight, prefabrication, workability, fastening method, removability, and high fire-resistance. As summarized:

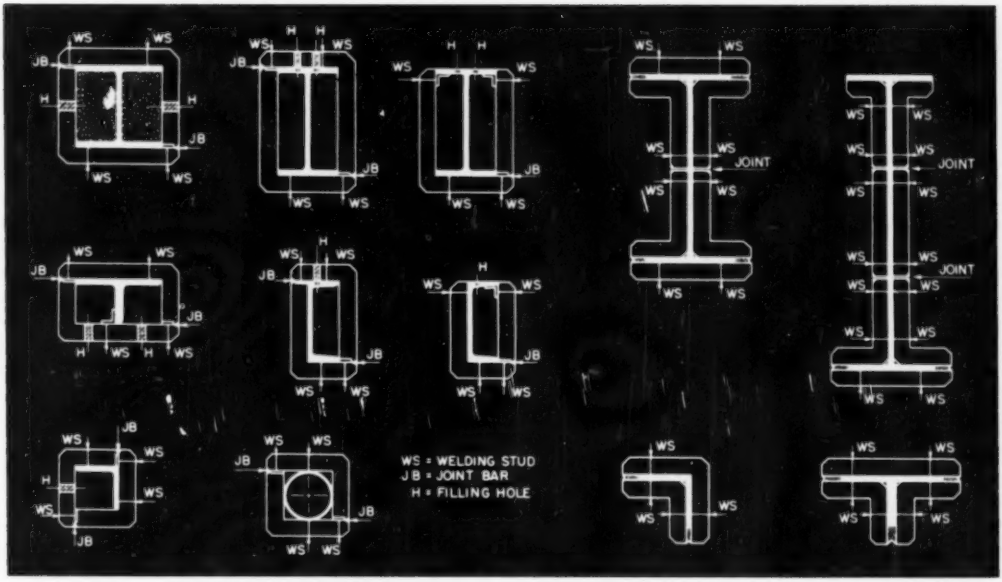
1 The weight being about 65% less makes it practical for one or two men to handle the fireproofing without costly hoisting devices. It also permits substantial savings in structural steel and foundation materials due to a sizeable reduction in the fireproofing dead loads.

2 No lumber is needed for forms and for shoring and miscellaneous materials, nor is any labor needed for assembling and dismantling forms when the poured concrete is used.

3 Clean-up is reduced to a negligible amount since rebound and dripping is cut to a minimum.

4 Shielding of non-fireproofed

*Mr. Kuhasz is a development engineer with M. W. Kellogg Co., at 225 Broadway, New York City. This article is based on his paper "Improved Methods for Fireproofing Structures," presented at the 7th Annual Petroleum Mechanical Engineering Conference, American Society of Mechanical Engineers, Kansas City, Mo., Sept. 22-24, 1952.



PREFABRICATED FIREPROOFING: boxed-in type at left, contour type at right

areas and equipment with tarpaulins is eliminated, along with eye protection for workers and work stoppage of other craftsmen in the vicinity from spraying or dripping materials.

5—Erection time is saved since the greater amount of work involved is done away from the job site. Work at the job is reduced to fastening the sections and filling the joints and openings. Overall completion time is improved considerably. Pre-fab sections can be made up well in advance of the time they are needed.

6—Workability of the perlite concrete after drying and curing puts it in about the same category as wood. It can be worked with most ordinary tools. Saws will cut it to dimension; holes can be drilled, and rough spots can be ground down.

7—Fastening the sections against flat and cylindrical surfaces by the threaded type welding studs and hex nuts decreases erection time also, because it does away with the necessity of bending, lacing, and welding wire mesh reinforcement and positioning the mesh a predetermined distance from the surfaces to be covered when regular concrete is used. Furthermore, in the case of sprayed-on concrete the need for welding metal clips to the surfaces used to support the shooting strips is eliminated.

8—Sections can be removed easily if they are damaged or when it is necessary to weld or do additional work on the covered surfaces. In the latter case, the same sections can be re-used and fitted to the new conditions without resorting to new materials. Furthermore, in the event of fire it is known that most fireproofing materials are severely damaged and, in many cases, must be removed in part or entirely. In the case of regular concrete this means it must be broken up and the reinforcement cut off. Prefab sections can be unbolted quickly and the same work accomplished with considerably less effort and time.

9—Sections made with the perlite aggregates have a higher degree of fire-resistance than regular sand and stone aggregates for concrete of the same thickness.

10—In terms of comparative costs, the following figures are on an actual installation where 924 linear ft. of structural steel members were fireproofed with 2-in. thick prefabrication fireproofing sections. All the members were encased with boxed-in type fireproofing. The size of the members ranged from 8-in. wide flange, 24 lbs., to 14-in. wide flange, 202 lbs.

Prefab method—installed cost was $7555. This was based on material cost of $4045 for 4800 sq. ft. of sections, 29 cu. yds. of fill, mortar, welding studs, and adapters; plus $3510 for field labor cost.

Formed method—installed cost was $11,163. This includes $2013 for 61 cu. yds. of concrete, wire and miscellaneous materials, plus $9150 for field labor, form requirements, and miscellaneous costs.

Savings calculated directly—$3608, or about 32.5%. This does not reflect savings in the amount of installed structural steel and foundation materials. For this particular case, the saving in fireproofing dead weight amounts to approximately 168,000 lbs.

Details of Method

Processed perlite aggregate, weighing 8 to 12 lb./cu.ft. and with a sieve analysis of 98% between No. 8 and 100 mesh, is used with type Ia air-entrained portland cement. The preferred aggregate-to-cement ratio is 4 or 5 to 1 by volume. The ingredients should be dry-mixed until of uniform color in a slow speed mortar type mixer. Water should be added and the mixing continued until wet ingredients are of uniform consistency, with a slump of not more than $2\frac{1}{2}$ in. The resulting density of the lightweight concrete mixture will vary between 50 and 60 lb./cu. ft. when cured.

Compared with regular sand and stone concrete, this density represents an average savings in dead weight of about 63%. The perlite mix will have a weight per board foot varying between 4.2 and 5 lbs., and its compressive strength will average about 900 psi. after 28 days.

Water should be clear and free from injurious amounts of oil, acid, organic matter or other deleterious substances. For reinforcement 2 by 2", #10 gauge galvanized welded wire mesh is used. In addition, $1\frac{1}{4}$-inch wide by $\frac{1}{8}$-inch thick metal joint bars with 90° welding studs, 3/16-in. in diameter are used in certain sections as discussed herein. (See Fig. 1)

Casting of Sections

The sections are limited to two shapes, 90° ells and flats which are made 2 in. thick in variable widths, and in general, 36 in. long. (See Fig. 2.) Prior to casting the sections, reinforcement is set taking care to see

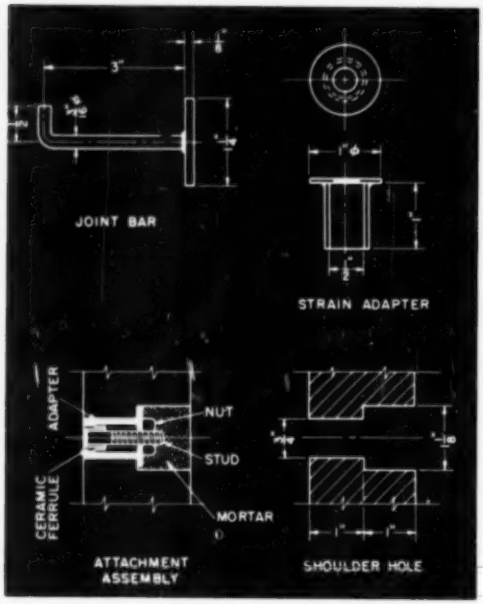


FIG. 1—Details of parts used in assembling prefab fireproofing

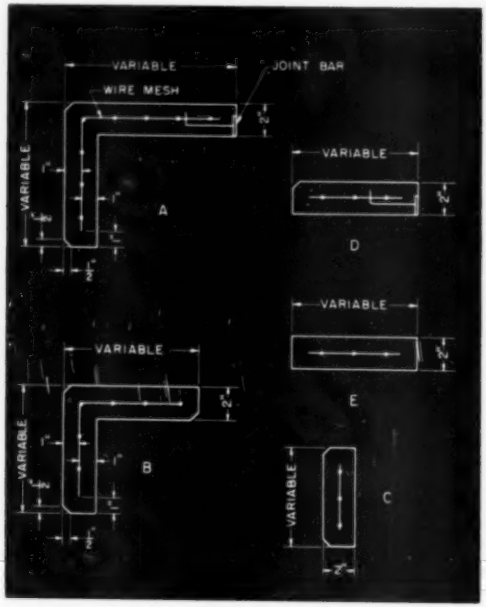


FIG. 2—Standard shapes of the two basic types of sections

that it is centered in the pans, wire spacers are used for this purpose and are made by cutting the wire mesh at several places and bending it at 90° so that it bears against the sides of the pan. Joint bars are set in the pans and the 90° welding studs are hooked to the reinforcement. In order to facilitate the work, all reinforcement and joint bars should be fabricated for the entire project before casting is started.

Before casting is started the pans should be sprayed with a light lubricating oil in order to facilitate removal of the section without damage while concrete is still wet. When placing the concrete in the pans, rodding and tamping should be employed to avoid honeycombing.

Vibrators are not recommended due to the great difference in material densities which tends to cause particle separation while being vibrated, resulting in the cement settling and the aggregate rising in the pans.

Screeds and trowels for finishing and weathering surfaces of the sections should be made of metal. With slumps of less than 2 in., finishing the top surface of the sections can be done as soon as the material is in place and finishing of the vertical surfaces within 2 or 3 hrs. after material has become firm. In order to finish the vertical surfaces, the side plates on the pans must be removed, so doing also facilitates drying of the concrete by allowing air to circulate around the section.

In general, when casting at temperatures above 70° F. and relative humidity around 50%, the sections can be removed from the pans within 24 hrs. Atmospheric drying and curing of the sections should be done under cover in order to prevent damage from excessive heat of the sun, rain and freezing. After removal of the sections from the pans, they should be stored on open racks to allow for air circulation around them and sufficient supports should be provided to prevent warping and bending of the sections. In order to control shrinkage and hair line cracks during the curing period, the sections should be wetted down at intervals of four hrs. for at least two days. In general, the sections should be allowed to cure for at least fourteen days before any work is done to them.

From actual practice it has been found that to encase the majority of structural steel and pipe profiles used in structures under various conditions of construction that the corner chamfers vary in position. It therefore is necessary to have removable chamfer pieces for placement in the pans as required. (See Fig. 2.) In general, shapes A, or A and D in combination are used for boxed-in fireproofing and shapes B, or B, C and E in combination for contoured fireproofing. It is to be noted that shapes A and D are always cast with a joint bar for their full length. Preferably the shoulder holes used for attachment should be drilled in the shop prior to shipment of the section; however, additional holes can be drilled in the field to suit, without damage to the sections.

Casting Pans

Adjustable metal pans of the cross section shown in Fig. 3 and made in 12-ft. lengths are used to cast six or more 36-inch long fireproofing sections. The pans are made in three parts, two of which are connected by a hinge and provided with adjustable and removable dams and chamfer pieces to permit the production of the various shapes as indicated in Fig. 4.

The cross sectional dimensions of the pans are such as to permit casting a fireproofing section one half the maximum depth of the largest mill fabricated structural steel profile. The purpose of the hinge is to facilitate the rapid removal of the fireproofing sections and reassembly of the pans for reuse; it also permits easy cleaning and oiling of the pans.

Erection Materials

In addition to the lightweight fireproofing sections described herein, these materials are required: strain adapters consisting of a ½-in. diameter steel ferrule spot welded to a 1-inch outside diameter steel washer with a 5/16-in. diameter hole; threaded welding studs ¼-in. in diameter by 1¾ in. long, furnished with a hexagonal nut and ceramic ferrule; mortar composed of one part of portland cement type Ia to three parts of perlite aggregate combined with 0.25 part of lime; metal tape ⅜ in. wide

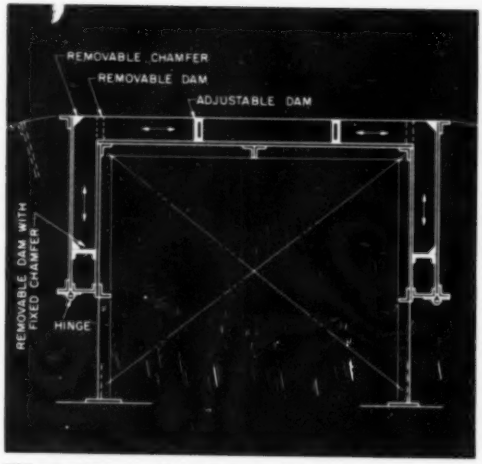


FIG. 3—Cross section of the adjustable metal pan in which sections are cast

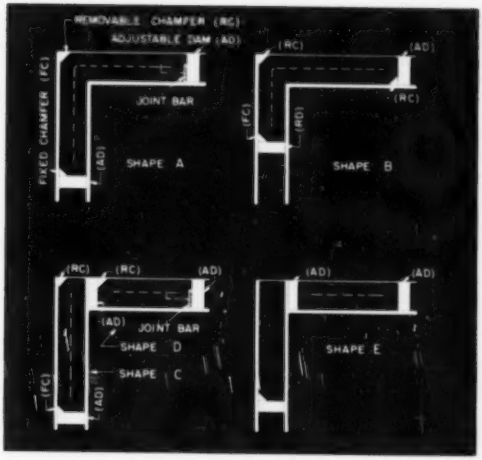


FIG. 4—Pan arrangements for casting standard shapes

of No. 24 gauge soft sheet steel.

In order to erect the fireproofing sections, these tools are required:

1—Power-operated drills, with a metal shoulder bit equipped with a depth guide for drilling the attachment holes.

2—Welding generators, 400-amp., for every two weld guns.

3—Weld guns of the time-volt-ampere type, equipped with proper chuck and ferrule holder for fastening welding studs.

4—Power-operated saws, equipped with at least a 9-in. diameter, thin abrasive blade for cutting the sections.

5—Power-operated grinders for smoothing out minor defects.

6—Manually-operated speed wrenches for tightening welding stud nuts.

7—Steel hand trowels for pointing up joints and packing space over studs.

Erection of Sections

Two general types of fireproofing are employed; boxed-in, using shapes A and D, and contoured, using shapes B, C and E as illustrated in Fig. 2.

Structural steel members that are encased in fireproofing should be given a coat of good zinc chromate paint prior to installing the fireproofing sections. The sections should be set in place and temporarily held in position manually or with metal tape. The studs and ceramic ferrule are then set into the chuck of the welding gun, after which the stud end of the gun is inserted into the shoulder hole and the stud welded to the structural member or to the joint bar in adjacent fireproofing section. Strain adapters are then inserted around the studs until they bear against the metal surface of the member or the joint bar, after which the nut is installed on the stud and tightened until sections are firmly held in place and joint between sections pulled up tight. Where it is necessary to cut a section to fit, measurements should be taken and the sections cut to dimension before installing them.

As soon as sections are securely held in place the V joints between the sections, shoulder holes for studs and any other openings in the sections should be wetted down and packed with mortar and then troweled smooth.

In places where joints are not square and edges not cut true or chamfers are required, the grinding tool can be used to rectify these conditions.

General

Boxed-in fireproofing is used for structural and pipe profiles up to and including 18 in. in depth and contoured fireproofing for greater depths. Where voids within fireproofing are required to be filled, $1\frac{1}{8}$-in. diameter holes should be drilled to permit placing low cement ratio lightweight perlite concrete.

The same shapes can be used for fireproofing around and over framing connections including rivet and bolt heads, or at these places reinforced perlite plaster may be used. Skirts of vessels, etc. may be fireproofed in the same manner.

Fire Test

Tests were performed and conducted by the Underwriters Laboratories, Inc. in Chicago on February 9, 1951, covered by Retardant 3351, dated June 4, 1951, Report on Precast Concrete Units for Fire Protection of Steel Columns.

The average temperatures at 4 hrs. for the four levels have been indicated in the following tabulation. It should be noted that these temperatures are well below the 1000° F. average and 1200° F. maximum allowed under the "Conditions of Acceptance" for Structural Steel Columns in the Standard Specifications for Fire Tests of Building Construction and Materials (ASTM E119-47) and below the 925° F. average allowed by the Building Code of the City of New York.

Level	Average ° F.
Upper level	650
Upper mid-level	665
Lower mid-level	530
Lower level	490

Maximum temperature at measured point 780° F.

The conduct of the fire test was controlled by the Standard Time-Temperature Curve where the following points on the curve determine its character (temperature surrounding test piece).

1000° F. at 5 min.
1300° F. at 10 min.
1550° F. at 30 min.
1700° F. at 1 hr.
1850° F. at 2 hrs.
2000° F. at 4 hrs.

It is to be noted that the sections tested were $1\frac{3}{4}$ in. thick and the void was filled with lightweight perlite concrete of a ratio of one part portland cement to eight parts of aggregate.

It also should be noted that structural members covered with a 2-in. thickness of portland cement and stone aggregate have been similarly tested and the average temperature of the steel member has been observed to range between 1000° F. and 1200° F. with an end point maximum temperature range between 1080° F. and 1350° F., depending on the kind of aggregate used, such as limestone, sandstone, gravel, traprock, granite, or cinders.

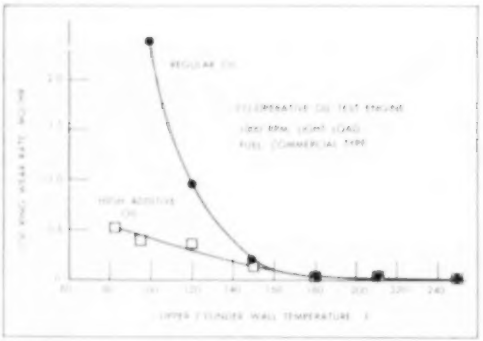


FIG. 1 Regular vs. high additive oil with varying cylinder wall temperatures

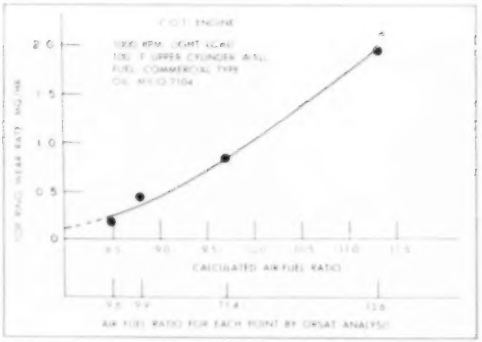


FIG. 2 Effect of air-fuel ratio on low temperature wear

ROLE of CORROSION in ENGINE

The work of various investigators is reviewed to show the influence of low temperature operation conditions and sulfur content of fuels on wear of cylinder walls and piston rings. Jacket temperature, oil, cylinder wall metallurgy and fuels are important variables in the corrosive wear of engines, and the resulting high oil consumption. Engine wear from this cause can be reduced through proper selection of oil and control of jacket temperature.

This paper was originally presented at a symposium on engine wear held by the Metropolitan Section, Society of Automotive Engineers, New York, Oct. 16, 1952. Another paper on that program dealt with friction as a cause of engine wear, a subject which was discussed in PETROLEUM PROCESSING, Sept. 1952, p. 1263.

IT HAS been known for a number of years that engines wear more rapidly when used intermittently than when used more or less continuously. Buses and salesmen's cars run 100,000 miles and more with only a very small amount of wear on the rings and cylinder walls providing reasonable maintenance practices are maintained. On the other hand engines in cars used for short trips wear rapidly on a mileage basis.

One of the earliest experimenters to investigate the factors controlling ring and cylinder wear was C. G. Williams.[1] Corrosion by carbonic acid formed from fuel combustion was suspected to be a factor, therefore tests were made using hydrogen instead of gasoline. This procedure reduced wear, which was again increased when carbon dioxide was added to the intake air.

At low jacket temperatures the differences were marked, whereas at high temperatures wear was low regardless of the fuel. The study also included an evaluation of austenitic cast irons, which have a higher resistance to corrosion, as cylinder materials. Wear was reduced by one half even though such metals are believed to be less resistant to abrasive wear. Williams concluded that corrosion was an important factor at low jacket temperatures.

In the past investigators have experienced many difficulties when measuring engine wear. Physical measurements are not reproducible for short tests because the amount removed is small. Lengthy tests are expensive and usually more subject to engine and operating variables. As a consequence considerable effort has been devoted to the development of shorter and more reproducible test methods. Moore[2] has reported on the chemical analysis of the crankcase oil for iron content. Pinotti[3] and Jackson[4,5] utilized radioisotopes to measure ring wear.

Recent Laboratory Studies

Fig. 1 from Jackson's work with radioactive tracers shows that low

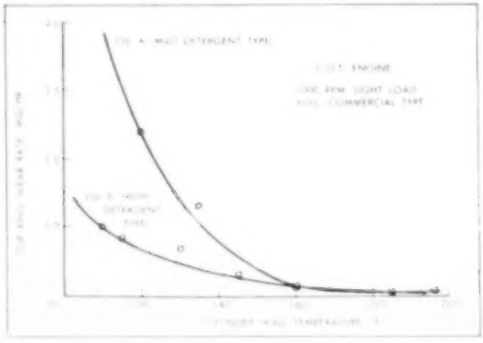


FIG. 5 Relative wear of Oil A vs. Oil B in laboratory engine with varying cylinder wall temperatures

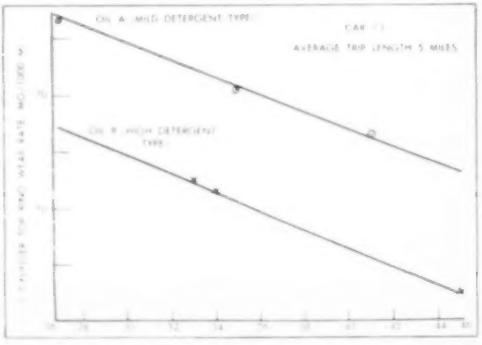


FIG. 6 Relative wear of Oil A vs. Oil B in Service Passenger Car No. 1 with varying atmospheric temperature

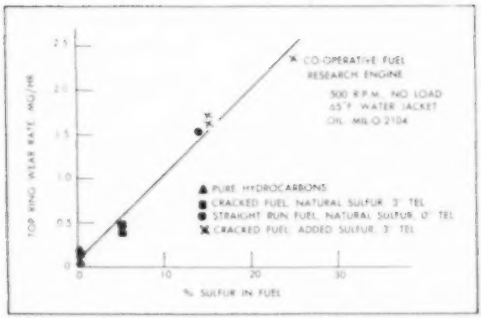

CO-OPERATIVE FUEL RESEARCH ENGINE
500 R.P.M., NO LOAD
65°F. WATER JACKET
OIL: MIL-O-2104
PURE HYDROCARBONS
CRACKED FUEL, NATURAL SULFUR, 3 cc TEL
STRAIGHT RUN FUEL, NATURAL SULFUR, 0 cc TEL
CRACKED FUEL, ADDED SULFUR, 3 cc TEL
TOP RING WEAR RATE, MG/HR
% SULFUR IN FUEL

FIG. 3—Effect of fuel sulfur on low temperature wear

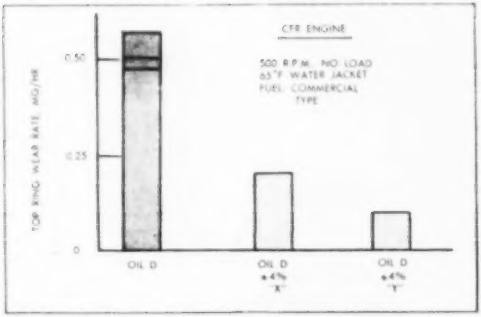


FIG. 4—Effect of oil additives on low temperature wear

WEAR

By J. C. GENIESSE and H. R. JACKSON
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cylinder wall temperatures can lead to high wear. At temperatures below 150° F. the wear increases very markedly. This temperature corresponds to the dew point of the exhaust gas. Below 150° F. water vapor will condense on the cylinder walls. Water and cast iron give rust which is wiped off by the rubbing action between the pitson rings and cylinder walls. Carbon dioxide and fuel acids dissolved in the water hasten the action giving rust corrosion. The upper curve in Fig. 1 is for a non-additive oil whereas the lower curve is for a high detergency oil containing additives which give rust protection when evaluated by ordinary rust tests.

Fig. 2 points out the fact that mixture ratio is another variable. The leaner mixture ratios give a higher rate of wear which can be attributed to the higher content of acids in the exhaust gas. Fig. 3 illustrates that sulfur contents of the gasoline above those now used will increase wear in engines operated with low jacket temperatures.

The type of oil used in the crankcase is also important, as shown in Fig. 4. The kind of detergent is also very important. A heavy duty oil is not the panacea. The fact that an oil meets the Mil-0-2104 specification is not significant since this specification is based on high temperature operation which is termed "Heavy Duty". Most passenger car operation is intermittent or better described as "severe service". It is unfortunate that the two types of service are so thoroughly confused. Actually "Heavy Duty" is a high temperature problem whereas "severe service" is a low temperature problem with oil contamination by water, soot and combustion acids.

Using iron content of the crankcase oil as a criterion, Ellis and Edgar[6] found that the cylinder wear at 160° F. jacket temperature was one-half as much as at 100° F. They also found that increasing the sulfur content of the Diesel fuel from 0.3% to 1.0% tripled the rate of wear when holding the jacket temperature at 100° F. The sulfur burns to form acid vapors which become corrosive when dissolved in water. Their experiments on engine speed while holding the jacket temperature constant showed this variable to be negligible. At higher speeds the time between power strokes is less but the wear rate per hour is the same indicating that time rather than mileage is the all important factor.

Field Results

Laboratory experiments have shown that corrosion may be responsible for engine wear, and that jacket temperature, oil, cylinder wall metallurgy and fuel are important variables. The importance of these factors on the road can only be determined by observations made in engines used in normal operations. Field tests are subject to operating conditions and engine design as well as fuel and lubricant variables, consequently they are more variable than controlled laboratory engine tests.

In this respect radioactive tracers have been of value. Figs. 5, 6, 7 and 8 point out the value of laboratory tests in predicting the results which may be obtained in typical passenger car service. In this series

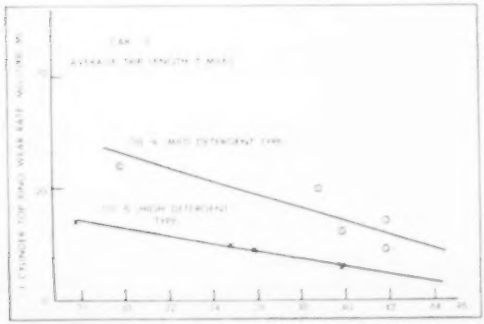

FIG. 7—Relative wear of Oil A vs. Oil B in Service Passenger Car No. 2 with varying atmospheric temperature

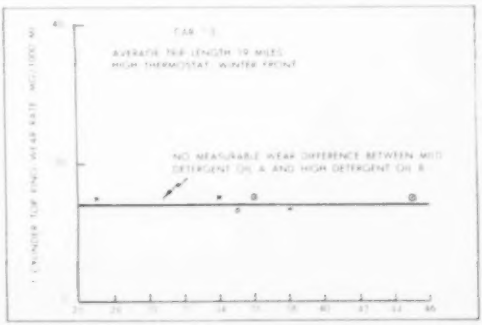

FIG. 8—Relative wear of Oil A vs. Oil B in Service Passenger Car No. 3 with varying atmospheric temperature

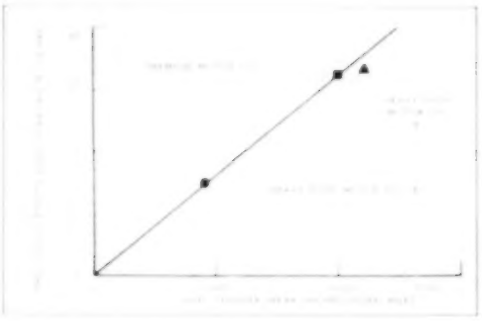

FIG. 9. Correlation of laboratory radioactive piston ring wear and service. From F. W. Kavanagh[7]

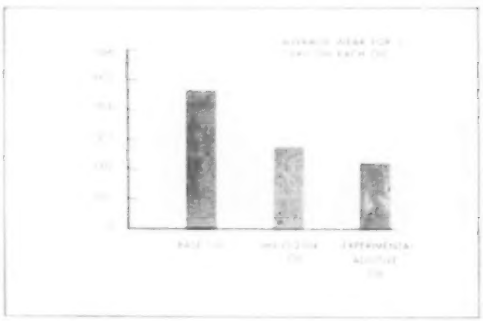

FIG. 10. Cylinder bore wear as affected by oil type. From J. L. Palmer[8]

a mild detergent oil is compared with a high detergent oil. Fig. 5 gives the effect of temperature in the laboratory engine, whereas the other graphs illustrate the experience obtained in typical passenger car service. Figs. 6 and 7 show the beneficial effects of rust protective type detergent oils, whereas Fig. 8 proves that proper temperature control, namely a winter front and a high thermostat setting, makes it unnecessary to use a special oil for corrosion protection.

Kavanagh[7] has also shown a relationship between laboratory and field tests which for this particular case is shown in Fig. 9. The radioactive tracer tests were conducted in a Chevrolet engine under FL-2 conditions whereas the field data were obtained by making physical measurements in a fleet of taxicabs. In both sets of data wear was reduced approximately 50% by introducing an oil of superior qualities.

Home-to-work service in passenger cars is typical of a high percentage of car operation particularly in the heavily populated areas. Palmer[8] reports a 50% decrease in wear by means of oils containing additives. The results based on 14,000 miles over a period of 15 months are plotted in Fig. 10.

Ellis and Edgar[6] investigated the effect of the alkalinity of high additive content oils and found a 60% reduction in wear in utility and delivery fleets which presumably operated under stop and go driving conditions. Oil G is an HD oil, J a premium oil whereas H is a high additive oil with high alkalinity. The data are given in Fig. 11.

Miller and Berry[9] reported the results of radioactive ring tests in a passenger car when driven under city and highway conditions. The results, in Fig. 12, show that wear can be reduced by one-half when an oil for MS (severe) service is used in place of one for ML (light) service. The tests also show that highway driving is not as wear producing as city driving with its more frequent stops.

Conclusion

Laboratory engine tests under carefully controlled conditions where variables may be isolated show that wear increases under temperature conditions where water may be condensed on the cylinder wall and that further increases are noted when acid vapor concentrations are raised. The use of oils which are known to have rust protective properties reduces this wear. Fleet tests of the intermittent types including taxicabs, delivery and utility cars and home-to-work passenger cars show that the wear of these vehicles is equally susceptible to the same types of oils, and to temperature.

It appears to the authors that corrosion need no longer be a major factor in engine wear since it can be very markedly reduced through the proper selection of oil and/or by controlling jacket temperatures.

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(2) "Effect of Nitrogen and Sulfur Content of Fuels on Diesel Engine Wear." C. C. Moore and W. L. Kent. *S.A.E. Transactions*, Vol. 1, 1947.

(3) "Application of Radioactive Tracers to Improvement of Automotive Fuels, Lubricants and Engines." P. L. Pinotti, D. E. Hull, and E. J. McLaughlin. *S.A.E. Transactions*, Vol. 3, 1949.

(4) "Some Phenomena of Engine Wear as Revealed by the Radioactive Tracer Technique." H. R. Jackson, F. C. Buck, L. J. Teed, and A. T. Colwell. *S.A.E. Transactions*, Vol. 6, 1952.

(5) "Laboratory and Field Wear Tests Using Radioactive Tracers." H. R. Jackson. S.A.E. Summer Meeting, June 1-6, 1952.

(6) "Wear Prevention by Alkaline Lubricating Oils." J. C. Ellis and J. A. Edgar. S.A.E. Summer Meeting, June 1-6, 1952.

(7) "Engine Wear—Comparison of Radioactive Wear and Field Measurements." F. W. Kavanagh. S.A.E. Sumer Meeting, June 1-6, 1952.

(8) "Effect of Heavy Duty Oils on Engine Wear in Typical Passenger Car Service." J. L. Palmer. S.A.E. Summer Meeting, June 1-6, 1952.

(9) "Tailoring Lubricating Oils to Fit Service Requirements." J. A. Miller and B. M. Berry. S.A.E. National West Coast Meeting, August 11-14, 1952.

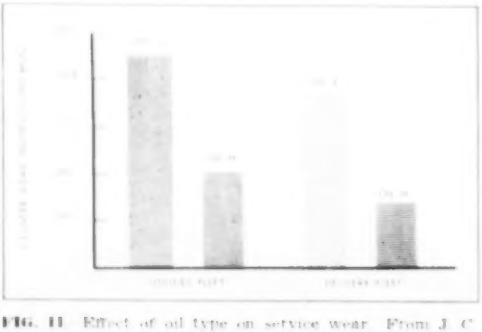


FIG. 11. Effect of oil type on service wear. From J. C. Ellis and J. A. Edgar[6]

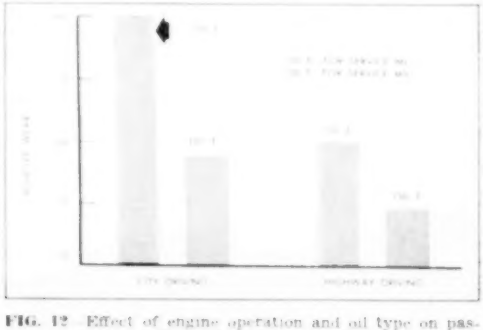


FIG. 12. Effect of engine operation and oil type on passenger car wear. From J. A. Miller and B. M. Berry[9]

Changes in the Patent Laws And What They Mean

By PETER J. GAYLOR
Gaylor, Cifelli & Jurick, Patent Attorneys, Newark, N. J.

AFTER considerable study and numerous discussions on the part of the patent bar, aided by concerted efforts of various government agencies, a Patent Codification Act was signed by President Truman on July 19, 1952, to take effect on January 1, 1953.

While the first draft contained some of the usual hair-brained proposals, including compulsory licensing, the final product resulted essentially in the present form of the patent law, with some minor but important revisions. At the present time, the petroleum industry obtains about 130 patents per week, or roughly about 5% of all patents issued. Obviously, the changes are of importance to the refiner and producer.

There is a decision known as "In re Thuau" which is being cited by the patent examiners as precedent in holding that a new use of an old composition is unpatentable. Chapter 10, Section 100(b) of the new Act now specifies:

> * * * The term "process" means process, art or method, and *includes a new use of a* known process, machine, manufacture, *composition of matter, or* material. * * *

Of course, it must be a *patentable* new use (that is, it must be a use which would involve invention and would not be obvious to one skilled in the art). Apparently, then, this provision opens new vistas to the inventor but, as is true with most codifications, the good intentions of the legislators do not often meet with the same interpretations by the courts.

Another quite controversial court decision rendered by (then Judge) Thurman Arnold, is the one in the case of Potts v. Coe. Potts worked for Teletype Corp., which is owned by American Telephone and Telegraph Corp. The decision, in effect, held that an invention made by the staff of a large corporation results in the general finding of the "needle", since enough people are put to searching the "haystack," so that:

> * * * Discovery which is the result of step-by-step experimentation is not invention. * * *

Chapter 10, Section 103 of the new Act now rightly specifies:

> * * * Patentability shall not be negatived by the manner in which the invention was made. * * *

So that, regardless of whether the inventor obtained the idea by "awakening suddenly from his sleep (a "flash of genius"), or whether he acquired it by methodical step-by-step experimentation, the manner in which the invention was made, is immaterial.

In the much-litigated case of Halliburton Oil Well Cementing Co. v. Walker, dealing with the Walker patent 2,156,519 on locating obstructions in oil wells, which patent finally was declared valid by the Supreme Court and then held invalid on rehearing, the Supreme Court finally decided that:

> * * * Where a patentee added an element to an old device, the claims are invalid which do not suggest the physical structure of the element, describe its physical relation to the old device, or describe the manner in which it will operate together with the old device so as to make the "new" unitary appartus perform its designated function. * * *

In this patent, the claims contained the term "*means* associated with said pressure responsive device for tuning said receiving means to the frequency of echoes from the tubing collars - - - ". The decision held that this terminology was objectionable since it included means that were not yet known or discovered at the time the patent application was filed.

Chapter 11, Section 112 of the new Act states that:

> * * * An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claims shall be construed to cover the corresponding structure, material, or acts described in the specification *and equivalents thereof*. * * *

This provision appears to nullify the Halliburton decision.

A Dime a Copy

Copies of the new Patent law, officially titled "Title 35, United States Code," can be obtained from the Government Printing Office, Washington 25, D. C. for 10c a copy. Refer to Public Law 593, 82nd Congress.

The new law also provides that if a joint inventor refuses to join in an application, the application may be filed, in spite of this, by the other inventor on behalf of himself and the omitted inventor. If an inventor refuses to sign an application, the assignee or other person having a proprietary interest in the invention, may file it. Divisional applications may be filed without the signature of the inventor. The law also allows addition of other inventors to a patent application if it subsequently is found that the invention is a joint one.

In recent years, there has not been any actual contributory infringement of a patent, to speak of, since it had been practically emasculated by court decisions. However, Chapter 28, Section 271(c) of the new Act provides that:

> * * * Whoever sells a component of a patented machine, manufacture, combination or composition, or a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringing use, shall be liable as a contributory infringer. * * *

It now appears that one could sue a party for contributory infringement if the article sold is a material part of the patented product or process and is not a staple article or commodity which is suitable for substantial noninfringing use.

Section 271(b) specifies that "whoever actively induces infringement of a patent shall be liable as an infringer". In other words, he would be considered a direct infringer, whereas now, if a manufacturer advertised a patented product for use in a patented composition he, at most, would be considered only as a contributory infringer, if at all.

Constant Struggle

As is apparent from the foregoing, there appears to be a constant struggle between the legislators and the courts. The latter, who often are prompted by the Department of Justice and its ideology, feel that they are rendering a service to the public when they emasculate or nullify a patent law or legislative intent thereon. They become overwhelmed by the term "patent monopoly" to such an extent that they often forget to keep in mind that one of the principle reasons as to why we are foremost in science and technology in this world of ours is that there has been an incentive to the inventor to create and produce new products and processes which eventually *will* become public property.

Progress in Shale Oil Processing

Products from Mines Bureau's Colorado retorting and refining operations show commercial promise

SHALE oil can be processed satisfactorily by conventional petroleum refining methods. Typical refinery products—gas, naphtha, light and heavy gas oils, residuum—have been produced in good yields and quality from crude oil retorted from shale mined at the Rifle, Colorado, demonstration plant of the Bureau of Mines.

A summary of the annual report by the Secretary of the Interior on the Bureau's synthetic liquid fuels program during 1951 shows that, in pilot plant scale operations in the range of 250-400 b/d:

1—The feasibility of refining by thermal means has been established, and it is now possible to direct more attention toward process development that will give the best possible quality and yields of product.

2—A crude oil suitable for pipeline transportation was produced by visbreaking.

3—Recycle cracking is an attractive method of refining such visbroken crude, because it gives high gasoline yields and would permit the use of available thermal equipment at existing refineries. In a recycle cracking run on crude shale oil, a naphtha yield of 19.6 vol.-% of charge was attained, along with 45.9 vol.-% residuum.

4—Experimental work has been continued on treating operations. Recent addition of TEL-blending facilities have made possible production of a gasoline from shale oil. The gasoline, as well as a Diesel fuel, has been in use on automotive equipment at Rifle for almost two years. Performance of both appears equal to corresponding petroleum products.

5—Geneva Steel Co. has tested a high-melting-point shale oil pitch to determine its suitability as a blending component for preparing metallurgical coke from Utah coal. Shale Diesel fuel was tested in a locomotive of the Denver & Rio Grande Western Railroad over a period of 754 hrs. Results of both tests were encouraging.

Investigations were continued from the previous year's program at Rifle's demonstration shale oil refinery on three types of thermal cracking operations—coking, recycle cracking, and visbreaking. In two runs, the coking process was modified to produce the pitch showing promise as a substitute for the coal-tar pitch now used as an additive to improve metallurgical coke by the steel industry. Other thermal operations included thermal reforming of shale gasoline—not investigated previously—and the preparation of several grades of road oil for service tests.

Coking

When applied to crude shale oil, coking may be used to produce (1) a combined liquid product suitable for hydrogenation, (2) a synthetic crude with viscosity and pour point suitable for pipeline transportation, or (3) gas oils suitable for further thermal cracking or for use, after treatment, as Diesel fuel.

Six coking runs were made in 1951, with crude shale oil as charge stock. One was a once-through operation; three were recycle delayed runs in which flash fractionator bottoms were combined with crude and returned to the heater; and in the other two runs, the crude charge entered the system via the flash chamber, and heater feed was drawn from the same point.

Fig. 1 shows the flow for two of these operations. The solid lines indicate the flow in the usual recycle delayed-coking procedure, and the dotted lines show the changes necessary for a once-through operation.

During a part of one once-through run, conditions were so adjusted that pitch instead of coke was produced in the coke chamber. The general characteristics of the pitch were as follows:

Softening point (R and B)	401° F
Volatile matter	46.4 wt.-%
Benzene-insoluble	50 wt.-%
Total sulfur	0.44 wt.-%
Nitrogen	3.95 wt.-%

This was the material which Geneva Steel tested with encouraging results as a substitute for coal-tar pitch.

Once-through coking procedures are satisfactory when a synthetic crude for pipeline movement is desired, or for such special applications as the pitch or the over-all reduction of the carbon-hydrogen ratio.

For more exacting requirements, such as producing a combined liquid product suitable for hydrogenation, it is desirable to recycle the heaviest portion of the liquid product. Table 1 details operating conditions for runs of this type, yields, and product properties, and Table 2 gives the analysis of the gas produced. The yield of total liquid product, as would be

Table 1—Recycle Delayed Coking of Crude Shale Oil

OPERATING CONDITIONS

	Heater		Flash chamber		Fractionator	
	Inlet	Outlet	Top	Top	Btms.
Temperature, °F	781	925	721	749	795
Pressure, psig	250	55	24		

Charging rate, Raw crude, bbl. per stream-day: 232.3
Recycle, bbl. per stream-day: 52.0

PRODUCT YIELDS AND PROPERTIES

	Crude charge	Naphtha	Light gas oil	Heavy gas oil	Coke	Gas	Loss	Product Blend
Yield, vol. %	100.0	13.1	29.7	41.3				
Yield, wt. %	100.0	10.8	27.8	44.6	5.0	6.2	1.1	
Gravity, °A.P.I.	19.9	50.4	29.4	17.8				24.5
Pour Point, °F	85		10	90				60
Viscosity, sec.								
S.U.S. at 100° F.			45.0					50.8
S.U.S. at 130° F.	132.1		40.2	149.8				47.1
S.U.S. at 210° F.	47.7			48.8				
Sulfur, wt. %	0.82	0.14	0.70	0.98				0.67
Nitrogen, wt. %	2.2	1.03	1.92	2.32				1.94
Tar acids, vol. %	1.2	1.0	2.5					1.0
Tar bases, vol. %	4.7	5.0	12.3					5.4
Cetane No.			32.9					
Octane No., M.M. (clear)		66.1						
3 cc. tetraethyllead		73.6						
Octane No., R.M. (clear)		74.6						
3 cc. tetraethyllead		81.5						
Hydrocarbon Analysis								
Olefins, vol. %		31.0	38.2					
Aromatics, vol. %		13.0	24.0					
Paraffins and naphthenes, vol. %		56.1	25.8					
A.S.T.M. distillation, corrected to 760 mm. Hg:								
I.B.P., °F	203	106	436	595				186
10% at °F	474	198	488	644				351
20% at °F	542	241	494	676				437
30% at °F	584	312	532					515
50% at °F		369	587					
E.P., °F	666	385	658	690				699
Recovery, vol. %	98.0	93.0	98.0	98.0				96.0

(1) Based on total distillate to 660° F.

expected, is lower than that from once-through coking; but the carbon residue of the heavy gas oil is greatly improved. Table 3 gives an analysis of coke produced in this operation.

Recycle Cracking

Earlier work has demonstrated that recycle cracking of crude shale oil gives good yields of naphtha but that variations in operating conditions can result in wide variations in product yield and quality. A series of runs were made with varying operating conditions to determine the optimum. More work will be eventually required, but several observations of value have been made:

1. A combination of low reaction-zone pressure with a relatively short reaction time (reaction chamber by-passed) gives excessive deposition of coke in the heater and is therefore impractical from an operating standpoint.

2. Low reaction-zone pressure and a longer reaction time give excellent yields of naphtha having a fair anti-knock value, but control of the operation is difficult.

3. The use of higher reaction-zone pressures with a short reaction time (reaction chamber by-passed) gives satisfactory operation and produces a good yield of naphtha having a fair octane number.

4. Maximum attainable pressures in the reaction chamber with consequent long reaction times and low recycle ratio produced a naphtha of relatively good anti-knock characteristics but resulted in lower yields.

5. Medium reaction-chamber pressures (150 to 200 psig) with resultant lower reaction times and higher recycle rations gave better yields of naphtha with good anti-knock ratings. This type of operation (see Fig. 2 for the flow diagram) shows much promise for processing both crude and visbroken shale oil.

Table 4 gives the properties of the crude charge and products for an operation conducted under medium-pressure conditions. Yields and related data are given. It is observed that a naphtha yield of 19.6 vol.-% was attained, and a 45.9 vol.-% of residuum.

Table 3—Coke Analysis (moisture-free)

Volatile matter, %	10.15
Fixed carbon, %	89.06
Ash, %	0.79
Total, %	100.00
Hydrogen, %	3.70
Carbon, %	87.24
Nitrogen, %	1.45
Oxygen, %	5.93
Sulfur, %	0.47
Ash, %	0.79
Total, %	100.00
Gross heating value, Btu/lb	14,979
Net heating value, Btu/lb	14,634
Real specific gravity	1.6582
Cell space, %	24.5
C/H ratio	23.56

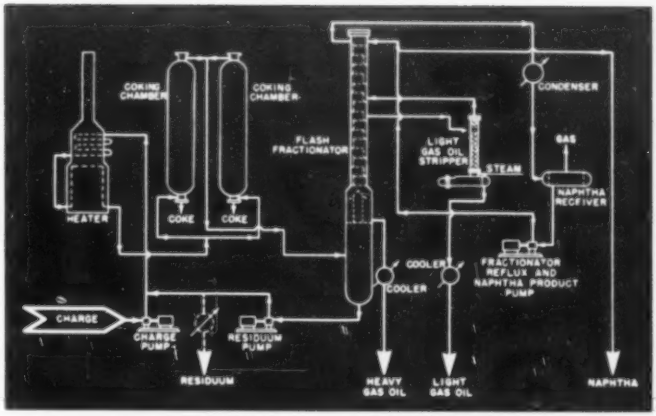


FIG. 1 Once-through and recycle delayed coking of crude shale oil

Table 2—Product-gas Analyses[1]

Operations and charge	Recycle coking N-T-U crude	Recycle cracking N-T-U crude[2]	Recycle cracking gas oil	Viscosity breaking N-T-U crude[2]	Reforming shale-oil naphtha
Hydrogen	11.9	5.4	3.8	5.0	8.3
Methane	38.7	41.8	37.3	56.0	66.6
Ethane	13.3	19.0	18.5	14.0	13.1
Propane	7.6	10.1	13.6	2.1	4.7
Butanes	4.1	3.1	4.1	.6	1.1
Pentanes	1.5	.5	1.7	.0	1.0
Hexanes	.2		.1	.0	.2
Ethylene	3.3	1.6	6.5	5.8	10.4
Propylene	5.2	6.1	8.7	1.5	6.2
Butenes	3.4	3.0	5.0	.2	1.6
Pentenes	2.6	1.0	2.1		1.3
Hexenes	1.0	.3	.6		.6
Heptenes	.1				
Nitrogen				5.7	2.9
Carbon dioxide	.7	1.2		2.0	.5
Carbon monoxide	2.6	1.1		5.2	
Hydrogen sulfide	3.5	2.1	.5	2.6	1.0
Molecular weight	28.2	27.6	30.6	21.3	24.7

[1] Analyses by mass spectrometer. All expressed in volume %.
[2] Absorber in operation.

Gas production was 7.7 wt.-% of charge. Analysis of the gas is shown in Table 2.

Recycle cracking is useful not only for processing crude shale oil but also for obtaining additional naphtha from gas oils produced in such operations as coking and visbreaking. As might be expected, the use of the cleaner, more refractory charge permits using higher heater-outlet temperatures than when crude shale oil is charged. Table 5 gives product yields, etc., for a typical run in which a mixture of

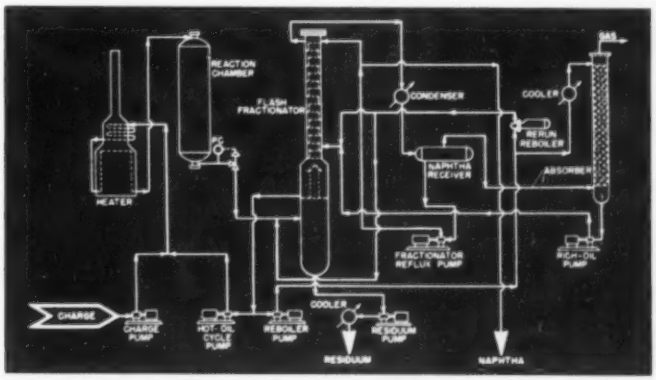


FIG. 2 Recycle cracking of crude shale oil

Table 4—Recycle Cracking of Retorted Crude Shale Oil

OPERATING CONDITIONS

Charging rate: Raw crude—bbl. per stream-day	36.0
Recycle—bbl. per stream-day	259.0

	Heater		Reaction chamber	Flash chamber	Fractionator	
	Inlet	Outlet	Top	Top	Top	Btms.
Temperature, °F	434	920	848	762	358	621
Pressure, psig	100	200	200	93		

PRODUCT YIELDS AND PROPERTIES

	Crude charge	Naphtha	Residuum	Gas	Loss	Recycle stock
Yields, vol. %	100.0	42.6	45.9			
Yields, wt. %	100.0	40.1	51.5	7.7	0.7	
Gravity, °A.P.I.	19.6	59.2	4.0			15.4
Pour Point, °F	85		80			25
Viscosity, sec.						
S.U.S. at 130° F.	132.7					40.5
S.U.S. at 210° F.	47.8		257			32.8
S.F.S. at 122° F.			738			
Sulfur, wt. %	0.82	0.72	0.96			0.76
Nitrogen, wt. %	2.19	1.10	3.07			2.87
Tar acids, vol. %	10.9	10.8				
Tar bases, vol. %	14.4	6.0				
Octane No., M.M. clear		71.0				
+ 3 c.c. tetraethyl lead		76.5				
Octane No., I.M. clear		74.0				
+ 3 c.c. tetraethyl lead		87.3				
Hydrocarbon analysis						
olefins, vol. %		16.1				
Aromatics, vol. %		17.5				
Paraffins and naphthenes, vol. %		35.2				
A.S.T.M. distillation corrected to 760 mm. Hg						
I.B.P., °F.	334	86	376			273
10% at °F.	489	143	597			466
20% at °F.	557	186	696			494
50% at °F.	693	290	907			527
90% at °F.		396				674
E.P., °F.	939	465	954			889
Recovery, vol. %	94	91.5	94.4			91.0

(1) Based on total distillate to 400° F.
(2) Nonwood vacuum distillation corrected to 760 mm. Hg.

Table 5—Recycle Cracking of Mixture of Light and Heavy Gas Oil

OPERATING CONDITIONS

Charging rate: Mixed gas oil—bbl. per stream-day	102.6
Recycle—bbl. per stream-day	309.0

	Heater		Flash chamber	Fractionator	
	Inlet	Outlet	Top	Top	Btms.
Temperature, °F	492	955	796	372	627
Pressure, psig	500	250	82		

PRODUCTS YIELDS AND PROPERTIES

	Raw charge	Naphtha	Residuum	Gas	Loss	Recycle stock
Yields, vol. %	100.0	32.5	62.2			
Yields, wt. %	100.0	27.8	84.0	7.8	—1.3	
Gravity, °A.P.I.	22.6	59.6	12.2			13.7
Pour Point, °F	75		90			90
Viscosity, sec.						
S.U.S. at 100° F.	89.7					92.6
S.U.S. at 130° F.	54.0		159.2			67.9
S.U.S. at 210° F.			37.8			
S.F.S. at 122° F.			21.7			
Sulfur, wt. %	0.81	0.68	0.82			0.81
Nitrogen, wt. %	1.56	0.83	2.81			2.67
Tar acids, vol. %		0.8				
Tar bases, vol. %		4.9				
Octane No., M.M. clear		65.0				
+ 3 c.c. tetraethyl lead		72.5				
Octane No., I.M. clear		74.1				
+ 3 c.c. tetraethyl lead		82.0				
Hydrocarbon analysis						
Olefins, vol. %		30.0				
Aromatics, vol. %		15.8				
Paraffins and naphthenes, vol. %		54.0				
A.S.T.M. distillation corrected to 760 mm. Hg						
I.B.P., °F.	490	110	204			470
10% at °F.	584	174	519			488
20% at °F.	535	210	579			513
50% at °F.	623	298	751			602
90% at °F.		382				
E.P., °F.	800	398	937			676
Recovery, vol. %	72.0	34.0	73.0			40.0

(1) Nonwood vacuum distillation corrected to 760 mm. Hg.

light and heavy gas oil was charged and a heater-outlet temperature of 985° F. was maintained. Raw naphtha obtained was 33.5 vol. % of the charge and was lower in sulfur content, and slightly lower in nitrogen, than that usually obtained by recycle cracking of crude shale oil.

Visbreaking seems most desirable for producing a crude suitable for piping to refineries on the west coast or other points a great distance from the oil-shale deposits. It requires a minimum of equipment and gives a high liquid yield with little gas. Also, it produces no residue, such as coke which, for reasons of economy, must be marketed at or near the point of production. Finally, vis-broken crude may be recycle-cracked to produce naphtha and fuel oil, with approximately the same yields as are obtained by recycle cracking of crude shale oil.

Crude shale oil was vis-broken using a conventional flow scheme. To evaluate the method for preparing pipeline crude, the fractions from the distillation column were recombined. Table 6 outlines operating conditions and results.

Reforming

Thermal reforming, used satisfactorily by the petroleum refiners for some time for improving octane of straight-run naphthas, had not been investigated at Rifle before 1951. Four exploratory runs were made to try to establish suitable working ranges of temperature, time, and pressure for shale gasoline. The first three runs were very brief because of operating difficulties. The last run overcame most of these problems. More runs will still be necessary to discover optimum relationship between yield and octane improvement.

The flow path used in the latest reforming operation is conventional. Results of operating with a heater-outlet temperature of 1010° F. and a pressure of 400 psig. are given in Table 7. The clear research octane number of the reformed naphtha was about four units better than that of the charge stock. The ASTM gum and induction periods were improved. No serious operating difficulties were encountered under the conditions shown.

Product Treatment

The cold-acid-treating plant at Rifle is capable of processing either shale naphtha or a gas-oil fraction intended as a Diesel fuel. Sequence of operations is (1) removal of tar acids by washing with dilute aqueous caustic soda solution, (2) removal of tar bases by contacting with dilute sulfuric acid, (3) a three-stage countercurrent treatment with concentrated sulfuric acid at controlled temperatures down to 10° F., followed by a water wash and caustic soda-neutralization, and (4) redistillation (when required) for end-point correction and polymer removal.

Shale naphtha and Diesel fuel are treated primarily for removal of sulfur and nitrogen compounds and other unstable materials. The treatment results in an improved storage stability, color, TEL susceptibility, or Cetane number. The tar acids and tar bases are removed before the concentrated acid treatment.

In 1951 the experimental program was designed to establish optimum operating conditions and reagent

quantities, and was supplemented by laboratory and large-scale investigations of the quality and performance of shale gasoline and Diesel fuel.

Gasoline

Two types of naphtha treatment have been studied. In the first, the total 400° F. end point naphtha is contacted with the desired quantity of concentrated sulfuric acid. In the second, the naphtha is fractionated into two cuts, the light one requiring only a mild treatment and the heavy one a more severe treatment.

Numerous test treatments have been applied to the 400 e.p. shale naphtha. The quantity of 66° Be. acid per bbl. of charge and the operating temperature were varied widely to permit comparisons between quality of product and reagent requirements. In a typical example of the treatment of a cracked shale naphtha the charge stock was contacted with 15.4 lbs. of 66° Be. sulfuric acid per bbl. of charge at 50° F. Before the concentrated acid treatment, aqueous caustic soda and dilute sulfuric acid exceeding stoichiometric quantities were employed to insure as thorough extraction of tar acids and tar bases as possible.

It is particularly interesting that the sulfur was reduced from 0.62 to 0.22% and that the reduction in gum content was good. Nitrogen was almost completely removed. The clear motor-method octane was reduced, but lead sensitivity was increased.

Diesel Fuel

To determine the suitability of shale oil as a source of Diesel fuel, several light-gas oil treating runs have been made. Two were on a rather large scale to produce enough fuel for extended test runs in Denver & Rio Grande Western Railroad equipment.

Treatment was the same as that on the gasoline. Tar acids and tar bases first were removed with dilute reagents. Then, after measuring and sampling, the oil was contacted with concentrated (66° Be.) sulfuric acid in three counter-current stages, using 10 lbs. per bbl. of charge, at 69° F. Since treatment did not appreciably change the distillation range or pour point, the product oil was not redistilled. However, it was stabilized by adding 0.05 vol.-% of a stabilizer produced by National Aluminate Co.

A test run was made with 5000 gals. on a standard General Motors EMD switching engine on the D & RGW railroad. The engine operated 751 hrs. During this period, the operating crews were unable to detect any difference in performance between the test fuel and the commercial product normally used. Fuel consumption was less than normal, but this may have been due in part at least to variations in the work load. At the end of the run, the engine showed no unusual deposits or accumulations on the cylinder heads or cylinders, or in the fuel injector or fuel filters.

A significant point revealed by the test run is that the engine performed excellently on a fuel containing 0.90% sulfur. The same unit has been sensitive to sulfur in petroleum Diesel fuel and had given trouble with sulfur contents of 0.4 to 0.5%. In shale oil distillates the sulfur compounds are largely thiophenic, and it appears they permit greater sulfur tolerances in engines of this type.

Further test work is being conducted on other by-products: road oils, tar acids and tar bases, and coke. Future refining studies are planned on thermal cracking, combination thermal-catalytic processing, catalytic treating, etc.

Table 6—Vicosity Breaking of Crude Shale Oil

OPERATING CONDITIONS

Charging rate, Raw crude—bbl. per stream-day: 263.4

	Heater Inlet	Heater Outlet	Flash chamber Top	Fractionator Top	Fractionator Btms.
Temperature—° F	350	925	785	414	677
Pressure—psig	530	200	52		

PRODUCT YIELDS AND PROPERTIES

	Raw charge	Naphtha	Light gas oil	Heavy gas oil	Residuum	Gas	Loss	Product blend
Yields—vol. %	100.0	3.22.7		29.6	45.7			
Yields—wt. %	100.0	19.8		29.2	48.2	0.6	2.2	
Gravity—° A.P.I.	19.8	52.8	32.8	21.8	11.7			20
Pour point—° F.	85		40	85				20
Viscosity—sec.								
S.U.S. at 100° F.			35.6	52.8				180
S.U.S. at 130° F.	128.1		59.9	95.4				88
S.U.S. at 210° F.	51.6				43.8			
S.F.S. at 122° F.					274			
Sulfur—wt. %	0.80	1.08	0.70	0.72	0.93			0.77
Nitrogen—wt. %	2.09	1.91	1.97	0.92	2.43			2.03
Tar acids—vol. %		1.0	4.2					
Tar bases—vol. %		5.3	11.0					
Cetane No.			28.7					
Octane No., M.M.—clear		68.7						
+3 cc. tetraethyllead		72.8						
Octane No., R.M.—clear		79.0						
+3 cc. tetraethyllead		84.2						
Hydrocarbon analysis:								
Olefins—vol. %		51.7						
Aromatics—vol. %		25.9						
Paraffins and naphthenes—vol. %		22.4						
A.S.T.M. distillation								
(Corrected to 760 mm. Hg)								
I.b.p.—° F.	330	98	434	479	0.676			1.98
10% at—° F.	489	170	496	529	704			390
20% at—° F.	557	231	417	555	817			512
50% at—° F.		308	438	633				675
90% at—° F.		381	493					
E.P.—° F.	699	393	505	699	940			699
Recovery—vol. %	48.0	95.5	99.0	74.5	45.0			62.0

(a) Combined yields of naphtha and light gas oil.
(b) Norwood vacuum distillation corrected to 760 mm. Hg.

Table 7—Thermal Reforming of Shale-oil Naphtha

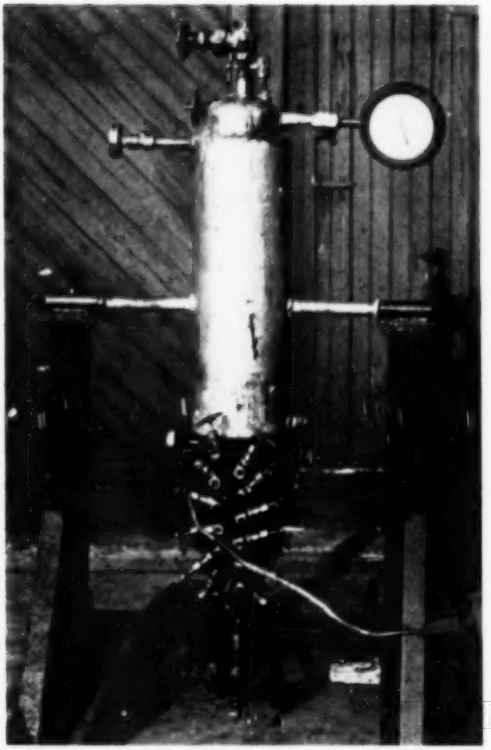
OPERATING CONDITIONS

Charging rate, bbl. per stream-day: 244.8

	Heater Inlet	Heater Outlet	Flash chamber Top	Fractionator Top	Fractionator Btms.
Temperature—° F.	1102	1.020	695	430	577
Pressure—psig	622	400	57		

PRODUCT YIELDS AND PROPERTIES

	Naphtha charge	Reformed naphtha	Residuum	Gas	Loss
Yields—vol. %	100.0	96.4	3.1		
Yields—wt. %	100.0	95.6	3.8	1.1	0.8
Gravity—° A.P.I.	50.0	51.5	15.7		
Pour point—° F.			0		
Gum, A.S.T.M.—mg./100 ml.	240	82			
Viscosity—sec.					
S.U.S. at 130° F.			99.1		
Sulfur—wt. %	0.81	0.83	0.76		
Nitrogen—wt. %	0.63	0.62	1.26		
Tar acids—vol. %	1.0	1.8			
Tar bases—vol. %	4.1	3.6			
Octane No., M.M.—clear	62.8	68.2			
+3 cc. tetraethyllead	71.2	73.6			
Octane No., R.M.—clear	70.3	74.6			
+3 cc. tetraethyllead	78.8	82.3			
Hydrocarbon analysis					
Olefins—vol. %	45.0	41.0			
Aromatics—vol. %	17.0	18.0			
Paraffins and naphthenes—vol. %	34.0	38.0			
A.S.T.M. distillation					
(Corrected to 760 mm. Hg)					
I.b.p.—° F.	139	121	243		
10% at—° F.	218	199	452		
20% at—° F.	250	237	578		
50% at—° F.	309	304	679		
90% at—° F.	372	366			
E.P.—° F.	402	401	699		
Recovery—vol. %	98.0	96.5	60.0		



DEASPHALTING BOMB used in the bench-scale method of deasphalting crude residue

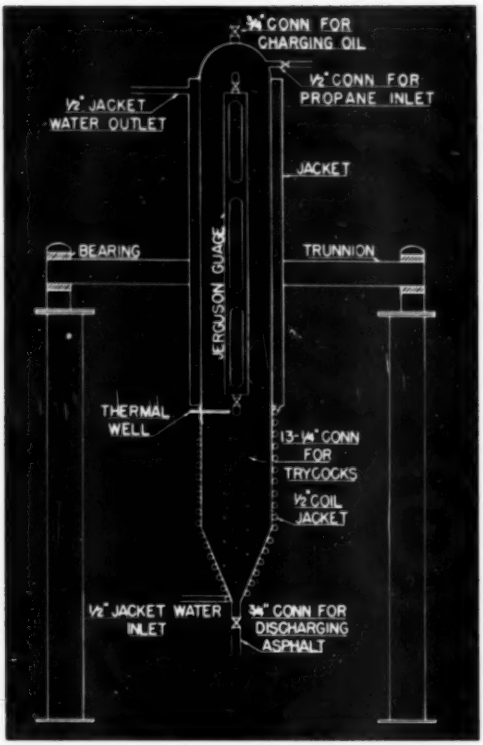


FIG. 1—DETAILS OF CONSTRUCTION of the deasphalting bomb

Propane Deasphalting of Residua

Bench scale test gives propane-to-oil ratios and temperatures correlating with commercial results

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THE propane deasphalting process has been in commercial use for the preparation of lubricating bright stock feeds from asphalt bearing crude residua for the past 18 years. When catalytic cracking came into wide use at the beginning of World War II, the need for highest yields of clean feed stocks led to the extension of the process to the production of catalytic feeds from residual stocks.

The propane deasphalting process supplements distillation by carrying separation according to molecular weight beyond the range of practical commercial distillation, permitting almost complete recovery of oil from asphaltic residua. The heavy oils produced crack catalytically more easily than distillate gas-oils but, when compared at the same level of conversion, produce similar results, particularly as regards carbon forming tendencies, according to available information. The salt contents of oils are reduced to very low figures by deasphalting, a matter of considerable concern in catalytic cracking.

Early deasphalting units consisted of a primary mixer and settler, with an asphalt wash mixer and settler in which the asphalt from the primary settler was contacted with fresh propane, the oil phase from this settler being returned to the primary mixer. This mixer and settler combination usually was followed by an identical mixer and settler set-up in which the oil was subjected to a secondary deasphalting or "deresining," by adding more propane at a higher temperature level. Soon it was realized that the process was similar in principle to the solvent extraction processes and a countercurrent tower operated under a 30° to 40° F. temperature gradient was substituted for the complicated mixer and settler system, with a marked improvement in yield and quality of product.

In studying the propane deasphalting of crude residua for lubes and catalytic cracking feed at the Foster Wheeler Research Laboratory it became evident there was a need for a simple batch method of deasphalting which would correlate with operation in efficient countercurrent towers with temperature gradient. Continuous pilot propane deasphalt-

Table 1—Stepwise Batch Deasphalting vs. Countercurrent Tower Operation

Stock	A		B			C			D		
	Lab. Tower	Batch Bomb	Plant	Batch Bomb	Batch Bomb	Plant	Batch Bomb	Batch Bomb	Plant	Batch Bomb	Batch Bomb
Propane Ratio	7:1	7:1	10.5:1	10.5:1	10.5:1	10:1	10:1	10:1	8.7:1	8.7:1	8.7:1
Deasphalting Temp., (Tower Top), °F.	160	160	152	152	152	138	138	170	160	160	185
1st Wash Temp., °F.		148		134	155		146	152		138	155
2nd Wash Temp., (Tower Bottom), °F.	140	138	137	111	125	134	134	134	115	115	125
Deasphalted oil Yield, %	77.7	77.6	80.1	71.2	64.3	76.3	79.3	79.8	62.8	70.6	64.4
Inspections											
Feed											
Gravity, °API	17.7	17.7	14.1	14.1	14.1	15.4	15.4	15.4	14.2	14.2	14.2
Vis. 210° F., SSU	405	405	983	983	983	922	922	922	880	880	880
Deasphalted Oil											
Gravity, °API	22.2	21.8	22.8	20.7	21.0	23.0	23.3	24.3	22.5	20.9	21.6
Vis. 210° F., SSU	145.6	150.2	150	200	180	134	142	130	150	190	170
Color, ASTM, Union	3	3½	2½	3	4½	4	4½	4½	4½	5	4½
Conradson Carbon, %	1.70	2.28	1.82	3.16	2.47	1.62	2.18	2.02	2.47	2.70	2.67
Asphalt											
Penetration, @ 77° F.	3	2	0	0	0	1	0	1	2	1	1
Softening Point, °F.	131	141	170	202	175	140	136	134	122	162	162

Stock	E		F		G		H		
	Lab. Tower	Batch Bomb	Plant	Batch Bomb	Plant	Batch Bomb	Plant	Batch Bomb	Batch Bomb
Propane Ratio	8.7:1	8.7:1	8.6:1	8.6:1	7.4:1	7.4:1	7:1	7:1	7:1
Deasphalting Temp., (Tower Top), °F.	170	170	164	164	144	144	170	150	170
1st Wash Temp., °F.		52		152		140		128	153
2nd Wash Temp., (Tower Bottom), °F.	152	152	150	150	136	136	150	140	130
Deasphalted Oil Yield, %	82.0	82.1	86.0	86.1	76.0	80.1	62.5	68.7	67.7
Inspections									
Feed									
Gravity, °API	13.9	13.9	13.7	13.7	13.9	13.9	13.7	13.7	13.7
Vis. 210° F., SSU	1067	1067	1067	1067	1067	1067	1067	1067	1067
Deasphalted Oil									
Gravity, °API	23.0	22.8	24.2	24.1	23.6	23.2	23.0	23.4	23.4
Vis. 210° F., SSU	125	130	120	120	282	235	147	204	154
Color, ASTM, Union	4½	4½	4½	4½	5	5	5	5	4½
Conradson Carbon, %	1.97	2.11	1.73	1.70	4.12	4.00	3.1	2.98	2.18
Asphalt									
Penetration, @ 77° F.	2	2	0.10	1.5	0	0	14	11	4
Softening Point, °F.	136	136	98	98	165	174	140	155	164

ing units are expensive to build because of the pressures employed and the very extensive instrumentation required. Running continuous pilot units is expensive because of the inherent necessity for shift operation. These units require rather large quantities of feed stock to complete a run, entirely unsuited for small scale preliminary workups.

A semi-bench scale batch method has been developed in which 800 to 2000 cc. of crude residuum can be propane deasphalted in a simple bomb contactor, giving products similar in quality and yield to those produced in a continuous countercurrent system under equivalent operating conditions. A complete deasphalting can be carried out in one shift by one operator. No instrumentation is required other than an ordinary pressure gauge and a laboratory thermometer. The whole equipment can be put together at very moderate cost from readily available materials.

The deasphalting bomb used in this work is shown in the accompanying photograph, and in the construction drawing, Fig. 1. The body of the bomb was made from a 3-ft. length of standard 6-in. pipe with a hemispherical top head and a conical bottom head welded on. Three-quarter-in. connections were provided at top and bottom for charging oil and discharging asphalt, respectively. The lower one-third of the cylindrical section and the upper part of the cone were provided with ¼-in. needle valves at levels 1-in. apart for location of interface level, and discharge of the oil-propane phase, while retaining the asphalt in the bomb. An additional ½-in. connection was provided at the top of the bomb for charging propane.

All of the cylindrical part of the bomb above the top needle valve was jacketed with a section of standard 8-in. pipe. The lower section and cone were closely wound with ½-in. copper tubing. Circulating water for temperature control was passed through the coil and jacket in series. The bomb was mounted on trunnions just above its center of gravity so that it could be rocked easily by hand to provide agitation. A Jerguson gauge was mounted on the side of the bomb to permit checking the propane level on charging. A thermometer well was welded into the shell of the bomb just below the jacket. The lower part of the bomb below the jacket was thoroughly insulated.

Experimental Procedure

Eight hundred to 1500 cc. of residuum were weighed into the bomb. Liquid propane was pressured into the bomb from a conventional propane cylinder. The propane charge was determined by weighing the propane cylinder and checked by observing the level in the Jerguson gauge on the bomb. The bomb was brought to temperature and agitated for 20 minutes. It then was locked in an upright position and the contents allowed to settle. When settling was complete the position of the interface between the upper and lower layers was determined by visual observation of the "bleed off" from the various ¼-in. drawoff valves. The oil-propane phase then was drawn off through the first valve above the interface directly into an open container, or through a length of copper tubing into a closed stripping still.

Wash propane equal in volume to the first application, then was pres-

Table 2—Effect of Propane Ratio in Stepwise Batch Deasphalting

Stock	A		B		C	
	Batch	Bomb	Batch	Bomb	Batch	Bomb
Propane Ratio	7 to 1	4 to 1	10.5 to 1	4 to 1	10 to 1	4 to 1
Deasphalting Temp. (Tower Top), °F.	166	170	185	175	158	185
1st Wash Temp., °F.	145	140	150	145	140	145
2nd Wash Temp. (Tower Bottom), °F.	120	100	125	120	114	105
Deasphalted Oil Yield, %	77.0	70.5	64.3	57.2	70.3	57.7
Inspections						
Feed						
Gravity, °API	17.7	17.7	14.1	14.1	19.4	19.4
Vis./210° F., SSU	409	409	985	985	322	322
Deasphalted Oil						
Gravity, °API	21.8	21.9	21.9	22.3	24.3	24.7
Vis./210° F., SSU	155	172	165	179	132	144
Color, ASTM, Diluted	4½	7	4½	6	4½	6
Conradson Carbon, %	2.28	2.77	2.42	2.76	2.34	2.59
Asphalt						
Penetration @ 77° F.	7	26	0	3	6	22
Softening Point, °F.	141	132	178	141	156	130

Stock	D		E		F	
	Batch	Bomb	Batch	Bomb	Batch	Bomb
Propane Ratio	8.7 to 1	4 to 1	8.7 to 1	4 to 1	7 to 1	4 to 1
Deasphalting Temp. (Tower Top), °F.	183	175	165	175	165	170
1st Wash Temp., °F.	170	140	146	145	135	138
2nd Wash Temp. (Tower Bottom), °F.	125	105	127	115	105	105
Deasphalted Oil Yield, %	64.4	62.5	85.4	63.9	67.4	61.1
Inspections						
Feed						
Gravity, °API	14.2	14.2	18.6	18.6	13.7	13.7
Vis./210° F., SSU	850	850	261	261	1107	1107
Deasphalted Oil						
Gravity, °API	21.6	21.7	22.0	22.3	21.3	21.7
Vis./210° F., SSU	168	169	146	145	190	194
Color, ASTM, Diluted	4½	5	5	6	4	3½
Conradson Carbon, %	2.67	2.77	2.70	2.84	2.84	2.76
Asphalt						
Penetration @ 77° F.	4	3	0	0	0	2
Softening Point, °F.	162	157	160	168	192	181

sured into the bomb and the process repeated, after which a second wash of the same volume was applied and the process repeated again. On the completion of the second wash the asphalt was withdrawn through the $\frac{3}{8}$-in. valve at the bottom of the bomb. The propane was allowed to evaporate from the product oil and asphalt, and final stripping accomplished by heating and blowing with nitrogen. The oil from the washing was combined with the oil from the primary deasphalting.

Results

Table 1 presents a comparison of results obtained in the stepwise batch deasphalting with those obtained in countercurrent systems under equivalent operating conditions. Data were obtained on eight residual stocks of varying characteristics. In four cases comparisons were made with modern plants having efficient countercurrent towers; in two cases the comparisons were made with a plant 4-stage mixer and settler system when operated countercurrently; and in two cases the comparisons were made with the Foster Wheeler pilot plant countercurrent tower.

In each comparison the propane ratio on each of the three dumps used in the batch operation was the same as the total propane ratio used in the countercurrent system. In each case a comparison was made in which the first dump was made at the same temperature as the tower top in the corresponding countercurrent operation, the second dump was made at a temperature half way between the tower top and tower bottom, and the third dump was made at the same temperature as the tower bottom in the corresponding countercurrent operation.

On stocks A, E, F, and G, where comparisons were made against the laboratory pilot plant tower and a plant 4-stage settler system operated countercurrently, the yields and product qualities checked fairly well. The colors and Conradson carbons, however, were slightly poorer on the batch operation in some cases. On stocks B, C, D, and H, where comparisons were made against modern plant towers, the batch method showed deasphalted oil products appreciably higher in viscosity and yield, and generally poorer as regards color and Conradson carbon.

In these cases a second series of runs was made in which the same propane ratios were maintained but the temperatures used in the batch operation were increased as much as 30 degrees. The results obtained were much more nearly in line with the plant results. The viscosities and yields were slightly higher than the plant, and the colors and Conradson carbons were slightly poorer. It may be concluded:

1) The batch method presented gives results closely comparable to countercurrent systems having a moderate number of theoretical stages when operated under equivalent conditions of temperature and propane ratio.

2) It is necessary to operate at somewhat higher temperatures to approach the results obtained in highly efficient countercurrent towers having a large number of theoretical stages.

3) In all cases where the viscosi-

Table 3—Effect of Precipitant Composition in Stepwise Batch Deasphalting

Stock	A			B			C		
Precipitant	Mix[1]	Mix[1]	Propane[2]	Mix[1]	Mix[1]	Propane[2]	Mix[1]	Mix[1]	Propane[2]
Propane Ratio	7 to 1	7 to 1	7 to 1	10.5 to 1	10.5 to 1	10.5 to 1	10 to 1	10 to 1	10 to 1
Deasphalting Temp. (Tower Top), °F.	160	161	166	132	147	152	158	152	158
1st Wash Temp., °F.	148	143	148	124	128	134	146	141	146
2nd Wash Temp. (Tower Bot.), °F.	140	125	130	117	112	117	134	129	134
Deasphalted Oil Yield, %	77.6	78.2	78.0	71.2	72.1	70.7	79.3	81.4	81.5
Inspections									
Feed									
Gravity, °API	17.7	17.7	17.7	14.1	14.1	14.1	19.4	19.4	19.4
Vis./210° F., SSU	408	408	408	983	983	983	322	322	322
Deasphalted Oil									
Gravity, °API	21.8	21.7	22.0	20.7	20.5	21.1	24.0	24.2	24.0
Vis./210° F., SSU	155	166	160	209	225	204	142	148	144
Color, ASTM, Dilute	4½	4½	4½	5½	6	5	4½	4	4½
Conradson Carbon, %	2.28	2.22	2.28	3.16	3.32	2.71	2.18	2.10	2.25
Asphalt									
Penetration @ 77° F.	7	5	6	0	0	0	6	2	3
Softening Point, °F.	161	152	158	202	211	202	156	160	176

Stock	D			E			H	
Precipitant	Mix[1]	Mix[1]	Propane[2]	Mix[1]	Mix[1]	Propane[2]	Mix[1]	Propane[2]
Propane Ratio	9.7 to 1	9.7 to 1	9.7 to 1	8.7 to 1	8.7 to 1	8.7 to 1	7 to 1	7 to 1
Deasphalting Temp. (Tower Top), °F.	160	155	160	170	165	170	150	150
1st Wash Temp., °F.	138	130	138	154	146	151	128	128
2nd Wash Temp. (Tower Bot.), °F.	115	110	115	132	127	132	105	105
Deasphalted Oil Yield, %	70.8	71.3	70.2	92.4	93.4	93.2	68.7	68.1
Inspections								
Feed								
Gravity, °API	14.2	14.2	14.2	18.6	18.6	18.6	13.7	13.7
Vis./210° F., SSU	880	880	880	261	261	261	1107	1107
Deasphalted Oil								
Gravity, °API	20.8	20.8	21.1	22.5	22.0	22.5	20.8	21.0
Vis./210° F., SSU	189	194	182	155	146	156	204	201
Color, ASTM, Dilute	6	8	8	4½	5	5	6	7
Conradson Carbon, %	2.70	3.13	2.76	2.11	2.70	2.52	2.98	2.96
Asphalt								
Penetration @ 77° F.	2	0	0	5	0	2	0	0
Softening Point, °F.	183	190	192	190	169	175	195	189

[1] 51% Propylene
[2] 95% Propane
[3] 42% Propylene

ties and yields obtained by the batch and countercurrent methods do not agree within experimental error the viscosities are in line with the yields obtained. In other words the same viscosity-yield relationship holds throughout, the batch method tending merely to give a slightly lower degree of refining.

4) The batch method gives slightly poorer colors and Conradson carbons for a given yield and viscosity than the countercurrent operation.

In general it may be concluded that the method is useful for preliminary deasphalting workups, giving accurate viscosity vs. yield relationships and conservative estimates of the colors and Conradson carbons of the deasphalted oils obtained. The yield and quality of asphalt obtained duplicates closely the material from the countercurrent operation. The propane ratio required for countercurrent operation may be predicted and the temperatures required for equivalent countercurrent operation will be the same or somewhat lower than in the batch operation.

Table 2 presents a series of comparisons of the effect of propane ratio on six of the stocks studied. In these comparisons the general trend toward lower yields and or decreased degree of refining is evident. However, in some cases, notably stocks C, D and E, it was possible to go from propane ratios of 9 or 10 to 1 down to 4 to 1 while retaining about the same product quality, without losing more than 2% in yield, by extending the temperature gradient. The possibility of operating at low ratios without serious loss in yield is a matter of considerable importance in the design of propane deasphalting units, particularly for catalytic cracking feed, as this permits considerable reduction in investment cost.

Table 3 presents the results of studies of precipitant composition made on six of the residual stocks studied. This study was made to answer definitely the long-standing question of the effect of propylene in the propane in deasphalting operations. Accordingly, in each comparison one batch run was made with pure (95%) propane. A second run was made under identical conditions with a propane-propylene mixture containing 40 to 50% propylene. A third run was made with the same propane-propylene mixture at the same ratio but at 5° F. lower temperature throughout. The results of the three runs on each comparison were almost within experimental error, but the data indicate that the difference in equivalent treating temperatures between propane and the propane-propylene mixture certainly is not over 5° F. and probably is much less for normal treating conditions.

In the production of heavy gas-oil for catalytic cracking feed the salt and ash content of the product is of vital interest. Table 4 presents these data on a number of the feed stocks and products both from plant and laboratory deasphaltings. Salt contents are reported as total chlorides, calculated as sodium chloride. Ash is reported as percent total ash. It will be noted that feed stock salt contents varying from 19 to 218 lb./1000 bbl. were reduced on propane deasphalting to 0.00 to 0.16 lb./1000

Table 4—Reduction of Salt and Ash by Propane Deasphalting

	FEED		PRODUCT LAB. BATCH		PRODUCT PLANT	
	Salt Content lb./1000 bbl.*	Ash %	Salt Content lb./1000 bbl.*	Ash %	Salt Content lb./1000 bbl.*	Ash %
Residuum B	31	0.065	0.08	0.0027		
Residuum C	65	0.064	0.09	0.0013	0.09	0.0027
Residuum D	34	0.055	0.09	0.0024	0.06	0.0012
Residuum E	214	0.112	0.16	0.0036	0.16	0.0034
Residuum L	18	0.058	0.09	0.0054		

* Total chloride reported as sodium chloride.

Table 5—Metal Reduction by Propane Deasphalting

(Residuum L: 1290 Vis. 210° F. residuum deasphalted in three 4.5 volume dumps of propane at 130, 125 and 105° F., respectively.)

	Spectrographic Analysis			Conventional Analysis	
	Vanadium Wt. %	Iron Wt. %	Nickel Wt. %	Salt Content lb./1000 Bbl.	Total Ash Wt. %
Feed	0.024	0.054	0.0032	18	0.0727
Deasphalted Oil (55% Yield)	0.00012	0.00005	0.00003	0.41	0.0175
Asphalt (45% Yield)	0.044	0.094	0.0058		

(As Water-soluble Chlorides as Na Cl)

bbl. The corresponding reduction in percent total ash was from 0.058 to 0.112 in the feed to 0.0012 to 0.0056 on the product. Unfortunately, the present state of knowledge of catalyst deactivation does not permit a straight-forward analysis for materials directly responsible for loss in catalyst activity. It is significant, however, that the stepwise batch deasphalting method correlates well with efficient countercurrent plant towers in salt and ash reduction and, therefore, should be a useful tool in future studies of catalytic cracking feed preparation. Also it should be pointed out that the product salt contents reported are low as compared to overhead cylinder stream from conventional distillation units, in the writers' experience.

Table 5 presents more detailed data on one stock where, in addition to the conventional salt and ash analyses, spectrographic analyses for vanadium, nickel, and iron were obtained on feed and products. These metals have been suspected of contributing to catalyst deactivation. The spectrographic data have the advantage of greater precision in the low ranges of concentration where the conventional analyses cease to have much meaning. Although the material balances in the spectrographic analyses are not perfect the data do indicate that at least 99.5% of the vanadium is removed on deasphalting, and possibly even higher percentages of iron and nickel.

There is enough background of commercial practice in the preparation of heavy catalytic cracking feed by propane deasphalting to demonstrate its practicability. Propane deasphalting in properly designed modern countercurrent towers makes possible the extraction of considerably more clean oil for catalytic cracking feed from crude residua than is possible by conventional vacuum distillation. Where it is necessary to reduce the production of residual fuel and obtain more feed for catalytic cracking the process becomes very attractive, particularly as the differential in price between residual fuel and "cat" feed need not be large to justify its use. The large degree of control which is possible over the quality of the asphalt produced offers the possibility in many cases of producing products having distinctive properties which may enhance their value for many purposes.

It is hoped that the batch deasphalting method presented in this paper will be of considerable help to the petroleum industry for the economical investigation of the applications of this process to the production of lube and catalytic cracking feed, and asphalts.

Summary

1. A bench scale batch deasphalting technique has been developed for the separation of asphalt from asphaltic crude residua which gives yields and product qualities very similar to those obtained in continuous countercurrent systems under operating conditions which can be correlated directly with countercurrent operation with temperature gradient.

2. It has been shown that on some residua operation with a low propane ratio and a wide temperature gradient will give nearly the same yields and quality as operation with normal ratio and gradient.

3. It has been shown that the replacement of as much as 50% of the propane with propylene has almost negligible effect on product yield and quality for any given treating conditions.

4. The bench scale batch deasphalting method presented in this paper has been shown to check very closely with plant countercurrent towers in reduction of salt and ash content which should make it a valuable tool in the study of propane deasphalting for the recovery of catalytic cracking feed from crude residua.

Acknowledgment

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John G. Ditman received his B. A. degree from Wooster College, Wooster, Ohio, in 1931 and four years later a Ph. D. in physical chemistry from New York University. He joined the Standard Oil Development Co. in 1935 and for the next two years worked as a chemist in SOD's process division. From 1937 to 1948 he headed the lubricating oil and wax group of Esso Standard Oil Co.'s petroleum technical service laboratory. Mr. Ditman is now a process design engineer with the Foster Wheeler Corp., a position he has held since joining the company in 1948.

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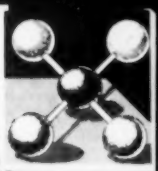

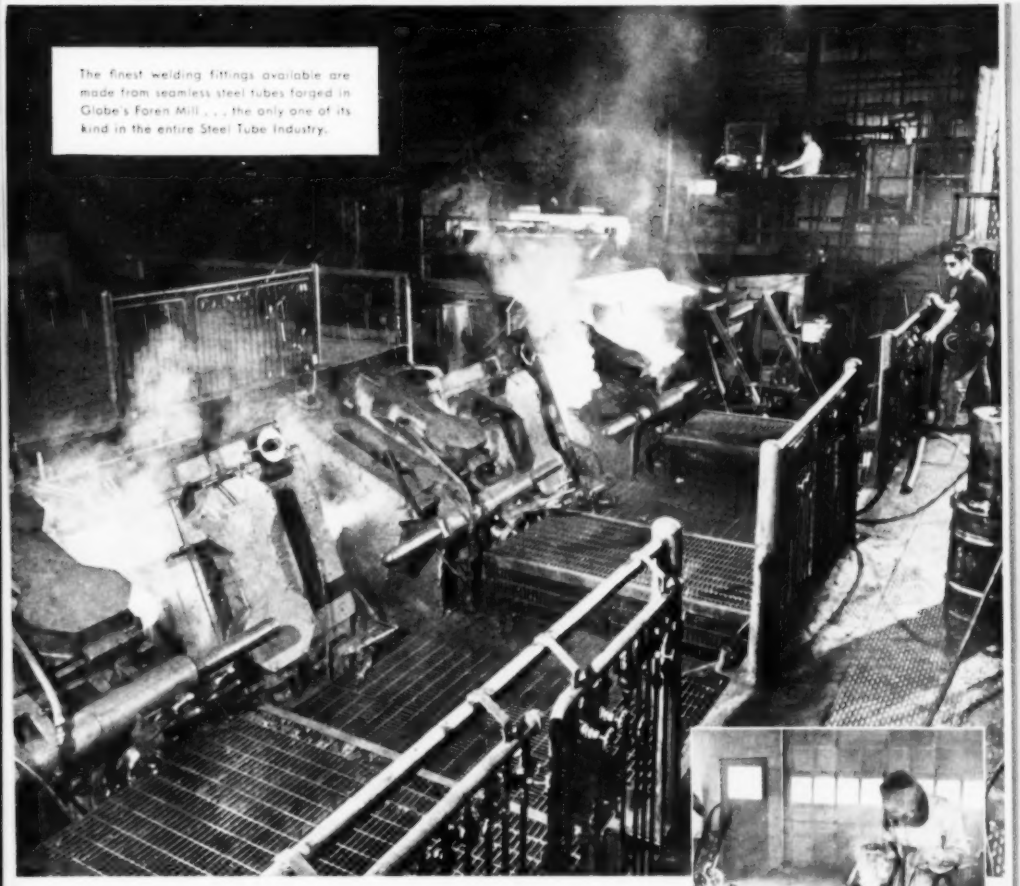
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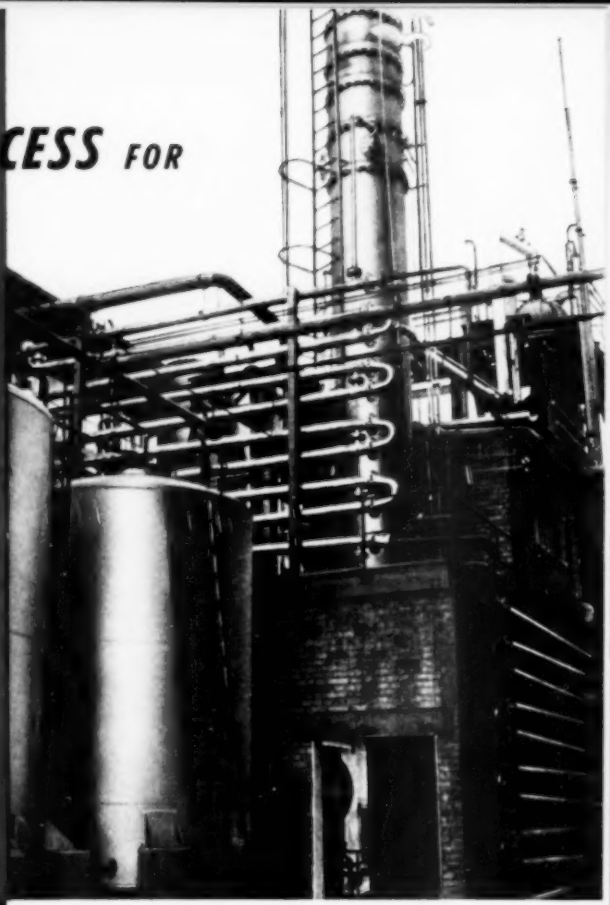

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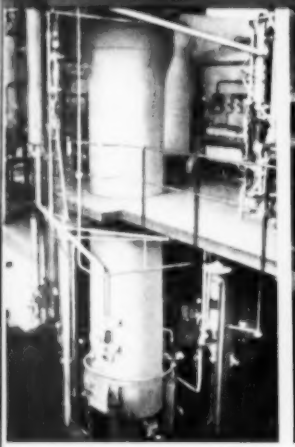

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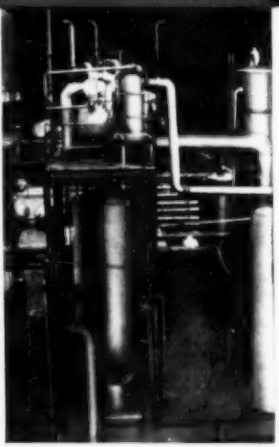

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ALIPHATIC BUILDING BLOCKS FOR *Petrochemical Textiles*

By PETER W. SHERWOOD
Chemical Engineer, New York

POTENTIALLY, the entire new field of wholly synthetic textiles is a job for the petrochemical industries. As yet, this field is still decidedly in its infancy. Nylon, the pioneer artificial fiber, still stands alone in large-volume production. Ultimate raw materials for this important fiber are wholly aromatic (or, by an alternate route, naphthenic). Thus, nylon is primarily derivative of the coal tar industry, although here, too, the ingress of the more versatile and flexible petrochemical industry is making itself felt.

But alternate synthetic textiles, having passed through the preliminary development, are now entering a substantial production stage. The expected growth during the current decade has been traced by the Materials Policy Commission[1]. See Table 1. As is always the case in such predictions, a principal restrictive factor stems from ignorance of potential new developments.

The same forecast sees a four-fold increase in total synthetic fiber production during the years 1950-75. These data illustrate well the magnitude of potential growth and unquestionably lean heavily on the conservative side.

For all the wholly synthetic fibers developed to date (i.e. excluding rayon, vicara, and similar textiles which are converted, naturally-occurring polymers), the petrochemical industries are the supplier par excellence of the required raw materials. This is the case even for aromatic building blocks, comprising above all benzene and p-xylene. To be sure, in the field of aromatic chemicals production, the coal tar industry has until now been the mainstay. However, this source is severely limited by its intimate tie-up with the relatively slow growth of the steel industries.

Still an alternate producer of aromatic raw materials is a coal hydrogenation industry, which may conceivably grow forth from the beginnings made at Carbide and Carbon Chemical Co.'s Institute, W. Va. plant.[2c] However, this industry's future is probably most intimately tied up with the growth of markets for polynuclear aromatics. At present we must quite certainly look to the petrochemical industries for the greater part of the required additional quantities of mononuclear aromatics.

In the field of aliphatic raw materials for synthetic fiber production, the preeminent role of the

Table 1—Forecasts of Synthetic Fiber Production
(millions of pounds)

	1950	1953	1960
Nylon	100	240	500
Orlon	6.5	37	125
Acrilan	—	30	100
Dynel	5	30	100
Dacron	—	25	150
Miscellaneous	45	115	200
Totals	**156.5**	**487**	**975**

Table 2—Chemical Requirements for Synthetic Fibers

(Millions of Pounds)

Year	Ethylene (1)*	Ethylene (2)	Acetylene*	Hydrogen Cyanide
1950	21.5		20	5.9
1953	102	7	71	49
1960	285	30	248	163
1975	1202	200	1104	566

* Ethylene in Column (1) and acetylene requirements are alternative.

petrochemical industries is, however, undisputed. The situation is well illustrated in the diagram on p. 1633.[1] Here are shown the various commercial routes selected for the production of the principal aliphatic building blocks for today's synthetic fibers, together with most of the companies employing the various basic processes.

It is in this field, more than almost any other, that the competitive position of acetylene and ethylene becomes apparent. Ethylene still holds a decided edge in the United States, but chemical acetylene utilization has been making important strides and it would be foolhardy to predict their relative standing in years to come.

Unquestionably, the two will grow side by side as competitive raw materials, but their relative preeminence will be influenced by a great many external economic and technological factors which cannot be properly evaluated now.

Ethylene itself is (in the United States) almost entirely a product of the petrochemical industries. The only significant alternate source is the dehydration of alcohol, an approach suited for large-scale operation only under the most exceptional circumstances.

Acetylene on the other hand has become a derivative of American petroleum sources only during the last three years. Prior to this time, it was wholly produced by the classical route via calcium carbide. Planners of new installations find themselves torn between the undoubted attractions of petrochemical acetylene production and the more established calcium carbide processes.

In the case of medium-sized units, economic advantage is usually still shown for the older method. However, production of intermediates for synthetic fibers calls mostly for large plants. In such instances, then, the economics of acetylene manufacture are intimately tied up with the raw materials and power cost situation at the plant site. It is obvious that this situation itself will be an influential factor in selecting plant location. Beyond that, consideration must be given to the possible utilization of byproducts in integrated plants (this is especially the case in the oxidative production of acetylene from hydrocarbons).

In any case, the cost difference between the classical carbide process and petrochemical means is small at many sites. It is small wonder then that, even where hydrocarbon cracking shows an economic advantage in preliminary calculations, preference has often been given to the well-established technique and economics of the carbide process.

As a result, this route has been selected for the majority of new installations. American pioneers in the field of hydrocarbon cracking for acetylene production have been Carbide and Carbon Chemicals Co. and Monsanto Chemical Co. (both plants are at Texas City, and both use a partial oxidation process).

Another primary building block of growing importance is hydrocyanic acid. Several methods are available for its production, including recovery from coke-oven gas and synthesis from formamide or from sodamide and coke.

Unquestionably the future of hydrocyanic acid production belongs to the petrochemical industries, however. The process which was pioneered on a commercial scale in 1949 at Rohm and Haas' Deer Park, Texas plant is based on the partial combustion of ammonia in the presence of methane, and will be discussed in more detail below.

One of the raw materials for this process, ammonia, is itself becoming a product of the petrochemical industries on a rapidly growing scale. Underlying its manufacture is, of course, the production of hydrogen from water (or synthesis) gas which, in turn, may be derived from coal, coke, or methane:

$$\left.\begin{aligned} CH_4 + 1\,2\,O_2 &\rightarrow CO + 2H_2 \\ CH_4 + H_2O &\rightarrow CO + 3H_2 \\ C + 1\,2\,O_2 &\rightarrow CO \\ C + H_2O &\rightarrow CO + H_2 \end{aligned}\right\} \quad (1)$$

CO in the product gas may be readily converted to hydrogen and carbon dioxide in accordance with the equation:

$$CO + H_2O \rightarrow CO_2 + H_2 \quad (2)$$

After removing carbon dioxide by scrubbing with water or with alkaline medium, hydrogen may be reacted catalytically with nitrogen at high pressures to yield ammonia:

$$N_2 + 3H_2 \rightarrow 2NH_3 \quad (3)$$

Ammonia and hydrogen production from methane is becoming of increasing importance. This aspect is, however, beyond the proper scope of this paper, and has been discussed by the author elsewhere.[4, 5, 6]

The route from the basic building block (ethylene, acetylene, and hydrocyanic acid) to the desired monomer leads via well-defined intermediate steps which are outlined in the diagram. At this stage, the ultimate source of acetylene or HCN is, of course, a matter of indifference. In their technological aspects and unquestionable ultimate growth, these manufacturing methods may certainly be incorporated into the system of petrochemical processes. The significant growth of the most important building blocks for petrotextiles is strikingly illustrated by Table 2.[1]

The following sections of this paper will be concerned with technological aspects of the production of building blocks for synthetic fibers.

Ethylene Production

Conversion of ethane and higher hydrocarbons to ethylene is a well-established manufacturing art. Its industrial aspects have been the subject of a number of papers by this author[7] and others.[8, 9, 10] Limitations of space forbid a detailed discussion of the various processes involved. The present article will therefore be confined to the highlights of the principal processes now in operation or in promising development.

From a purely technical point of view, ethane is the ideal raw material for producing ethylene. If carried out at suitable operating conditions, the dehydrogenation reaction

$$C_2H_6 \rightarrow C_2H_4 + H_2 \quad (4)$$

is accompanied by a minimum of primary side reactions, and yields as high as 89.6% have been reported. The reaction attains a pseudo-equilibrium. However, at reaction conditions, the primary product will undergo secondary pyrolytic reactions which eventually lead to the formation of methane, coke, and hydrogen.

Ethane, with little other commercial value, has of late become the principal cracking stock in the manufacture of ethylene. This has not always been the case, however. Reaction conditions required for this conversion are very drastic and the demands made on the materials of construction have severely limited the commercial feasibility in many instances. The important strides made in the field of high-temperature alloys during recent years have helped to overcome these difficulties to a large extent.

There are however, even today, considerations which will determine the choice of a higher hydrocarbon as charging stock for ethylene production. These include inaccessibility of a suitable ethane supply (higher hydrocarbons can be shipped more readily); non-existence of a proper market for LPG products, and notably for propane; concomitant need for a source of propylene or butene, to be used in other refinery or petrochemical operations at the plant site.

As the paraffin chain of the charge

stock is lengthened, an increasing number of primary pyrolytic reactions can take place, and the maximum yield of ethylene decreases accordingly. Thus, the pyrolysis of propane can take place by two routes, (to ethylene plus methane, and to propylene plus hydrogen), while the breakdown of butane can take three paths.

An ideal conversion per pass (on fresh propane) is about 35% to form roughly equal parts of ethylene and propylene (with the former predominating slightly). If desired, propylene may be recycled to the cracker. However, its coke-forming polymerization reactions are relatively high, and its contribution to ethylene formation is correspondingly reduced.

As a rough rule, commercial ultimate yields of 75 wt.-% (80% of theory) may be obtained in the cracking of ethane. Ethylene yield from propane is 45-50 wt.-%, and from gas oil 25-32%. These typical operating figures are, of course, modified by the interrelation between once-through conversion and ultimate yield.

Insofar as this writer knows, every American commercial installation for the production of ethylene from hydrocarbon feedstock is based on thermal cracking in tubular furnaces. While catalysts have been used successfully for the dehydrogenation of butane and propane to the corresponding olefins, no catalyst has so far been developed which promotes satisfactorily the dehydrogenation of ethane or which accelerates preferentially the thermal breakdown of higher hydrocarbons to ethylene and by-products.

Processes which deserve alternate consideration include regenerative thermal cracking (e.g., in the Wulff furnace[10]) to be discussed later in connection with acetylene) and ethylene production by the partial oxidation of ethane. This latter approach has been used commercially at Leuna, Germany and has recently been developed, on a wholly different basis, by Universal Oil Products Co.

Among thermal cracking processes, the most common scheme involves cracking in a pipe still at temperatures between 1400 and 1500° F. Outlet pressure varies between 10 and 30 psig., the lower pressure being favored for a relatively high-molecular-weight feedstock with its greater tendency toward side reactions. Normal residence time varies between 0.7 and 1.6 seconds and flexibility is given to furnace operation by varying the outlet temperature.

For any given contact time, a boost in the mean reaction temperature will decrease the overall yield of ethylene, but it will raise the per-pass conversion and with it the cracker capacity. An economic balance must therefore be struck between ethylene output of the furnace and raw materials utilization.

Because of the severe materials difficulties and high construction costs of coil-type furnaces for ethylene production, alternate processes for the high-temperature thermal cracking of hydrocarbons have been developed.

Most important is the Thermofor pyrolysis of Socony-Vacuum Oil Co. which is an outgrowth of Thermofor catalytic cracking.

Two primary elements make up the Thermofor pyrolytic system: A reaction chamber and a primary heater. The hydrocarbon is introduced into the lower (reactor) chamber where it is contacted countercurrently by highly preheated pebbles. The cracked gases leaving the reactor are immediately quenched in order to minimize subsequent yield losses due to polymerization and condensation reactions. The pebbles leaving the bottom of the reactor are lifted to the upper (heater) chamber where they are heated in direct contact with burning fuel gas. Coke formed in the course of the reaction step is removed from the pebbles in the heating chamber where it serves as supplemental fuel.

The process is thus characterized by high thermal efficiency, operability with a large range of feedstocks, and suitability for high operating temperatures and consequent high throughputs (absence of metal failure problems permits operation as high as 1700° F.). At the same time, the problem due to coke formation is neatly solved. Disadvantages rest principally in the need for a mechanical conveying system and in the loss of pebbles (made of high-temperature-resistant ceramic) by spalling and abrasion.

An alternate approach to recuperative heat exchange in the cracking of hydrocarbons to ethylene is based on cyclical operation; i.e., the same chamber serves, at different times, for fuel combustion and for cracking purposes. Typical of this design is the Wulff furnace[10], which will be discussed in more detail in the section on acetylene production. This writer does not, however, know of any commercial installation employing the principle of cyclical recuperative heat exchange for ethylene production.

Brief consideration must be given to the principle of partial combustion for the manufacture of ethylene. The objective of this type of process is to break down ethane to ethylene and hydrogen by reacting the latter with oxygen without destroying the product olefin. Due to the peculiar chain reaction mechanism of hydrocarbon oxidation (which has been explored in detail by Lewis and von Elbe, but which is clearly beyond the scope of the present paper), it is possible to oxidize byproduct hydrogen selectively and to minimize the destruction of ethane and ethylene by carrying out the partial combustion reaction in the presence of large surfaces.

The only known commercial installation utilizing this principle (at Leuna, Germany) reacted ethane with oxygen of approximately 95% purity. The reactants are mixed in the ratio 3 to 1 after having been preheated to as high a temperature as feasible (1100 and 750° F., respectively). The reaction is carried out in a refractory chamber filled with ceramic spheres. Operating conditions are 3-400 mm Hg absolute and 1620° F. maximum temperature. Overall ethylene yield is 60-65%.

More recently, Universal Oil Products has developed a partial combustion process, using air instead of costly oxygen. The process is characterized by high permissible conversion per pass (up to 96%), with a corresponding yield of 60%, has been obtained in the case of ethane cracking).

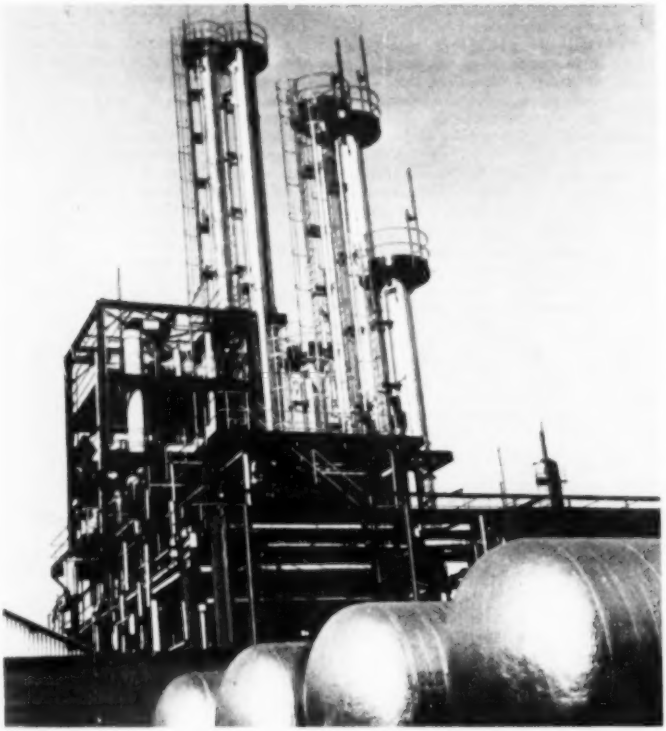
High thermal efficiency means, in this process, low hydrocarbon destruction and consequent high yields. It is therefore imperative to preheat the reactants before they enter the reactor. Feeds of low ethane content may be used satisfactorily. Indeed, according to Deanesly and Watkins[11], the presence of methane may actually serve to raise the overall efficiency of ethane cracking by being utilized as fuel in the process. The reported ethylene concentration of the product gases is about the same as that obtained in a tubular reactor. The processing problems are therefore expected to be of the same order of magnitude.

Ethylene Purification

Of the four commercially successful methods for the separation and purification of ethylene from cracked gases, straight low-temperature fractionation is the one most commonly employed. Beyond the problems met in ordinary fractionation, this operation is further complicated by the need for drying the feed gas thoroughly and selecting construction materials suitable for the subzero operating temperatures.

In a typical installation, the separation of ethylene is centered on the two main fractionation towers. In the methane tower; hydrogen, methane, and possibly other light products are separated from ethylene, ethane, and higher hydrocarbons. The tower bottoms pass to the ethylene tower in which the desired olefin is taken overhead, leaving the bulk of the heavier components in the still bottoms, to be further processed by fractionation or recycle cracking, or to be disposed as fuel.

An alternate approach involves removal of the bulk of this higher hy-



A PETROCHEMICAL TEXTILE STARTING POINT—ethylene fractionators and storage tanks at Dow Chemical Co.

drocarbon in a C_3 and C_4— lower prior to introduction into the methane column. This latter design is particularly suitable if the amount of C_5— and higher hydrocarbons is relatively large.

Separation in the methane tower is comparatively simple. Relative volatility of the key components is five, and only little reflux is required. Pressure operation (450-600 psig) is commonly employed with corresponding reflux temperatures in the range of —130° F. (at 575 psi). A variety of schemes may be employed for providing the necessary refrigeration. Most commonly, primary precooling is achieved by ammonia or freon refrigeration, but the final reflux cooling is accomplished by indirect heat exchange with ethylene product or ethane being vaporized at reduced pressures.

Demethanization is also, in isolated instances, being carried out at substantially atmospheric pressure. The extremely low operating temperatures (around —240° F.) required under such circumstances may be achieved by such means as refrigerating highly compressed methane overhead with liquid ethane and finally liquefying it in part by Joule-Thomson expansion into the fractionation column where it serves as reflux.

Special demands are placed on the materials of construction in a unit of this kind by the extremely low temperatures involved. Aluminum is known to serve to good advantage. Considerable experience in this field has, of course, been developed by the growth of the oxygen industry.

More difficult is the separation of ethylene contained in the bottoms leaving the demethanizer. In pressure operation (say at 400 psig), an ethylene column of 50-60 plates is called for at a 3:1 reflux ratio. Since the top temperature in such a column is as high as 0° F., no serious refrigeration problem is posed. In atmospheric towers, on the other hand, the reflux temperature is around —145° F. Again some scheme involving the flashing of pressurized, sub-cooled reflux ethylene is employed to provide the necessary cooling effect.

In most of the chemical processes involved in the production of aliphatic raw materials for petrotextiles, ethylene purities of 94-96% are adequate. This goal is readily accomplished in the fractionation here discussed. More careful purification is required only for special uses; e.g., for the production of polyethylene.

All of the high-temperature processes employed for the production of ethylene from ethane and higher hydrocarbons will yield a small amount of acetylene as byproduct. This material is found in the ethylene product, generally in a concentration range of 1-2%. Where its removal is required by the subsequent operating steps, this can be accomplished by a variety of means which include absorption in acetone, or in less volatile but more expensive acetonyl acetone.

An alternative and very elegant method for the almost quantitative removal of acetylene is found in its preferential hydrogenation to ethylene in the presence of nickel oxide-chromium oxide or palladium-silica gel catalysts. The conversion is, of course carried out directly on the cracker gas, which contains more than enough hydrogen for this purpose.

To execute the hydrogenation step successfully, it is necessary that the feed stream be almost quantitatively free of sulfur compounds. A small amount of ethylene is simultaneously hydrogenated with the ethane; in the overall picture ethylene is neither gained nor lost during the hydrogenation step for acetylene.

Low-temperature fractionation is the predominant process for ethylene purification but other approaches can, and do, substitute for it in whole or in part. Of primary importance in this connection is the oil scrubbing step employed in place of the low-temperature demethanizer tower.

Absorption methods become increasingly attractive as the ethylene content of the raw gas decreases (note that there is a lower limit to this statement in the range 2-5% ethylene, when hypersorption is looked on with increasing favor).

A typical installation of this kind is found at Monsanto Chemical Co.'s Texas City plant. Primary absorption is carried out by means of an aromatic oil at 450 psig and 70° F. The lower part of the absorber column serves as primary stripper in which the fat oil is heated to 250° F. In this manner the methane content of the effluent sorbate is held to less than 4%. (based on ethylene content).

The fat oil leaving the bottom of the absorber column is passed to a stripper operated at 425 psig, in which the oil is regenerated by heating it to 450° F. The overhead consists of ethylene and higher hydrocarbons which are subjected to low-temperature fractionation in the manner described above.

Hypersorption finds increasing interest in the field of ethylene purification. Indeed, the first commercial

hypersorber installation, at Dow Chemical Co., served to recover ethylene from a lean feed gas (5.8%). Recovery of ethylene in this unit has been reported to be 98% efficient. The product gas contains 95.2% ethylene (on a carbon dioxide-free basis).

Operation of the continuous counter-current adsorption unit dubbed "Hypersorber" has been described repeatedly in the pages of this magazine (notably in the publications of C. Berg). Its application to the particular field of ethylene recovery differs from other functions merely in detail of design, and further description is therefore believed superfluous.

Recovery of ethylene by absorption in solutions of cuprous salts has not so far found commercial application in the United States. The process is based on chemical affinity exhibited by certain cuprous salts for some of the lower olefins (and which is widely employed in the recovery of butadiene).

Of the various systems developed to date, the most promising appears to be a solution of cuprous nitrate in aqueous ammoniacal monoethanolamine. Ethylene solubility in this medium is a pronounced function of pressure. Theoretical (equimolar) solubility is never achieved. At elevated pressures, the degree of ethylene absorption reaches an assymptotic value not exceeding 0.8 moles of ethylene per mole of cuprous nitrate present.

One such operation, on which the author has previously reported[7], carried out the absorption stage at 300 psig, using a feed gas with an ethylene content of 36.25%. The ethylene-rich liquid leaving the absorption tower contains some mechanically entrained ethane which is removed by expanding the solution to 40 psig. The evolved ethane-ethylene mixture is recompressed and returned to the absorption stage.

The de-ethanized solution is finally freed of ethylene by reducing the pressure to 150 mm. Hg. at 100-105° F. The stripped olefin is subsequently washed with sulfuric acid to remove any entrained ammonia. Final purification is accomplished by an alkaline wash for the removal of carbon dioxide.

To prevent the hazardous formation of copper acetylides, the quantitative removal of acetylene is necessary prior to absorption. Applicable hydrogenation processes have been briefly outlined above. Costs of this intermediate purification step, and its requirements for the total absence of sulfur compounds, impose a severe limitation on the use of cuprous salt absorption for ethylene recovery in most instances.

Acetylene Production

The promising potential of acetylene as a competitor to ethylene in a wide segment of the chemical industries has recently been carefully traced by Guthrie[13]. Its specific position in the field of synthetic fibers has been stated in the introduction to this paper.

Petrochemical acetylene is a newcomer to the American scene. Its attractive economics under suitable conditions have resulted in much developmental activity during recent years. In addition, the two large-scale acetylene-from-methane plants, referred to above, are approaching the operating stage.

The underlying reaction involved in the production of acetylene from methane is:

$$2\,CH_4 + 174{,}000\ \text{Btu.} \rightarrow C_2H_2 + 3H_2\ \text{(at 1250° C.)} \qquad (5)$$

The very large endothermic heat of reaction can be supplied to the system in one of three ways:

(1) By electric discharge through the gas.

(2) By supplying heat from an auxiliary fuel either in indirect heat exchange or in a regenerative furnace.

(3) By simultaneously burning some of the feed gas by the admixture of oxygen.

At this writing, only partial combustion processes have achieved large-scale production in the United States. In addition a semi-commercial plant has reportedly been producing acetylene by the regenerative cracking of methane at Los Angeles, Cal. for over a year now.

The inherent advantage of the *oxidative method* for acetylene production is the simultaneous formation of large quantities of synthesis gas which may be utilized in a number of chemical operations (production of hydrogen, OXO process, methanol production, etc.).

Source of this synthesis gas is partial combustion of methane which is called upon to balance the endothermic heat requirements of Equation (5):

$$CH_4 + 1/2O_2 \rightarrow CO + 2H_2 + 9900\ \text{Btu.} \qquad (6)$$

Existing interest in the partial combustion of natural gas for acetylene production centers around the Sachsse process on which adequate information has become available in recent years.[14, 15]

In this process, the reaction is carried out in ceramic burners of special design, engineered for uniform mixing of the reactants and uniform flow. The retention time of the gases in the burning zone (at 1500° C.) is about 0.01 seconds, after which they are immediately quenched with a water spray, to minimize the subsequent breakdown of the desired product.

The operation is carried out at a slightly positive pressure. In order to reduce the oxygen and methane consumption, the reactants are separately preheated to the highest feasible temperature and are then mixed. In the original Sachsse installation at Oppau, Germany, the degree of preheat was limited to 400° C. to minimize the danger of backflashing in the burner.

The oxygen/methane ratio must be carefully controlled; the optimum is about 0.65. Too little oxygen will decrease the extent of the reaction and oxygen in the exit gas increases. Too much oxygen results in reduced acetylene yields due to excessive burning of hydrocarbons.

Acetylene yield is approximately 31% of theory. A typical outlet gas contains some 8-9% acetylene and 80% synthesis gas ($CO + H_2$). Most of the remainder is unconverted methane and carbon dioxide, which is present within the limits of the water gas equilibrium at the reaction temperature level.

The process is hampered economically by the need for an oxygen plant (however, tonnage oxygen of 92-95% concentration is satisfactory). In addition to the simultaneous formation of synthesis gas, simplicity of reactor design and low electric power consumption are important factors in favor of the method.

Commercial interest has also been shown in the Wulff process[11] for the regenerative cracking of methane to acetylene. Licensing agreements make this system available through Girdler Corp., Fluor Corp., Ltd., and The Lummus Co.

Heart of the Wulff process is a cyclically operated cracking furnace which is suitably packed with refractory brick. Spaces between the bricks are used for gas flow and are designed to obtain the short permissible contact time (.01-.04 seconds). During the "make" period, natural gas enters the bottom of the furnace. In the course of its upward passage, heat is rapidly imparted to the gas by contact with the highly preheated refractory. On its way from the center of the furnace to the outlet, the cracked gas temperature is again rapidly reduced by contact with cold brick. At the conclusion of the "make" period, the natural gas feed is switched to an alternate furnace. The off-stream unit is, in the meanwhile, reheated by fuel gas combustion. During this part of the cycle, the brick on the after-cooler side of the reactor is suitably cooled by means of air. The principal feature of the Wulff furnace appears to be the high rate of heat transfer to a gas stream, achieved by very high gas velocities.

An alternate regenerative means for cracking methane to acetylene has been operated on a pilot-plant scale at Germany's Ruhrchemie, A.G. In this installation, a water-quench was employed for subcooling the

make gas. The cracking reaction was carried out under partial vacuum with consequently high recompression costs. Methane consumption (including fuel gas) is reported at 118 cu. ft. /lb. acetylene produced.

The third approach to acetylene production from methane is based on electric discharge. Two systems have received attention: the electric arc process which is, even today, being practiced on a commercial scale at Huls, Germany, and the silent electric discharge (using a rotary electrode), developed by Texas University's Schoch. Both of these processes seem to require the same amount of electric power per pound of acetylene as is called for in the classical carbide process (5.5-6.0 kwh).

Economic considerations thus confine interest in these methods to sites where cheap electrical power is available. It should be noted that electrical discharge processes are relatively sparing in their consumption of methane (around 65 cu. ft. /lb. acetylene).

All of the above processes are also applicable to higher hydrocarbons. If the charging stock is a readily vaporizable, saturated paraffinic hydrocarbon, acetylene yield tends to be somewhat higher than in the case of methane feed. However, present-day economics clearly favor the use of relatively inexpensive natural gas as starting material.

Purifying Petrochemical Acetylene

All of the above processes produce acetylene in a concentration of 8-16%. To be useful in subsequent syntheses, acetylene of much higher purity is required. Several processes are available for the required purification step.

Water scrubbing at elevated pressures has found some commercial application in Europe. Because of the high power costs and the need for very large scrubber and stripping towers, this system is finding only limited favor in the United States. (One report has it that Monsanto Chemical Co. is banking on this method).

In general, preference is shown for the use of selective solvents for acetylene compounds, notably for dimethyl formamide, acetonyl acetone, etc.

Interest has also been shown in the use of hypersorption equipment for the removal of acetylene from the cracker stream. Paper economics for this approach appear promising, but more information remains to be developed. Use of hypersorption equipment in the recovery of acetylene seems to have a particularly attractive potential in conjunction with the partial oxidation process in which a quite dilute cracker gas is formed.

Production of Hydrogen Cyanide

A glance at the diagram on page 1633 makes it instantly apparent that hydrogen cyanide is the third and last primary petrochemical from which the aliphatic building blocks for synthetic fiber production are derived.

Perhaps, by strict interpretation of the word, hydrogen cyanide, produced from methane and ammonia must be looked upon as a secondary product of the petrochemical industries. For one of its raw materials—ammonia—is in its own turn largely a derivative of methane. It is, however, felt that the production of a clearly inorganic chemical does not properly belong within the defined scope of the present paper.

The process is based on the partial combustion of ammonia in the presence of methane:

$$2\,CH_4 + 3O_2 + 2NH_3 \rightarrow 2HCN + 6H_2O \qquad (7)$$

The best feed gas for the reaction has been found to contain approximately equivalent quantities of methane and ammonia and somewhat less than the theoretical amount of air. A typical reaction mixture contains 11% ammonia and 12% methane, the remainder being air. Overall yield, based on ammonia, is around 85%. Principal product of ammonia degradation is elemental nitrogen.

The highly exothermic reaction (3820 Btu./lb. HCN) resembles the catalytic oxidation of ammonia both in mechanism and in manner of technical execution. The preferred catalyst is platinum and platinum-rhodium gauze. Other catalysts which have been employed for ammonia oxidation have also proved successful for the production of hydrocyanic acid. Most important among these are bismuth oxide-promoted iron oxide, cerium oxide on silica gel, etc. The reaction is preferably carried out at an inlet temperature of 1470-1830° F. The theoretical rise in gas temperature is between 7-900° F.

The postulated reaction mechanism involves the intermediate formation of nitroxyl:

$$(1)\ NH_3 + O_2 \rightarrow NH_2 \cdot O_2 \rightarrow HNO + H_2O \qquad (7a)$$

$$(2)\ HNO + CH_4 \rightarrow HNO \cdot H_2CH_2 \rightarrow HN \cdot CH_2 + H_2O \qquad (7b)$$

$$(3)\ HNCH_2 \rightarrow HCN + H_2 \qquad (7c)$$

While insufficient oxygen is made available to convert the entire ammonia to hydrogen cyanide, there is surplus oxygen above the amount needed for the degree of conversion actually achieved (about 60% per pass). This oxygen is largely reacted with methane to form carbon monoxide and water. Formation of carbon dioxide is nearly negligible.

Suitable product recovery involves the initial extraction of ammonia from the product gases by sulfuric acid scrubbing. Hydrogen cyanide is then removed from the residual gas by scrubbing with cold water. It is finally stripped from the aqueous solution and is separated from residual water by fractionation. An important by-product of this operating scheme is ammonium sulfate which may be sold to the fertilizer industry.

Typical consumption of primary raw materials is 1.1 lbs. ammonia and 28-30 cu. ft. methane per lb. hydrogen cyanide.

Liquefied hydrocyanic acid may be stored as such. There is, however, some danger of spontaneous polymerization at explosive rates, especially in the presence of small amounts of alkaline material. Precautionary measures include the rigorous exclusion of all basic compounds and the use of suitable inhibitors.

Alternate means of storage include its conversion to acetone cyanhydrin by reaction with acetone in the presence of an alkaline catalyst. The compound so formed can be decomposed almost quantitatively at elevated temperatures for the regeneration of its components. Acetone cyanhydrin is therefore an efficient and comparatively safe method to ship hydrocyanic acid.

Where hydrogen cyanide is produced and consumed at the same plant, the tendency is to keep hydrogen cyanide inventory at the minimum compatible with good operating practice. The effort is made to react it with ethylene oxide or acetylene for the formation of ethylene cyanhydrin or acrylonitrile, respectively, with a minimum of intermediate storage. In this manner, the hazards of hydrogen cyanide storage can be largely side-stepped.

Note: this concludes the first part of this article on aliphatic building blocks for petrochemical textiles, covering the raw materials. A second part, dealing with the conversion of these materials to aliphatic monomers which may be polymerized to the fibers, will appear in an early issue.

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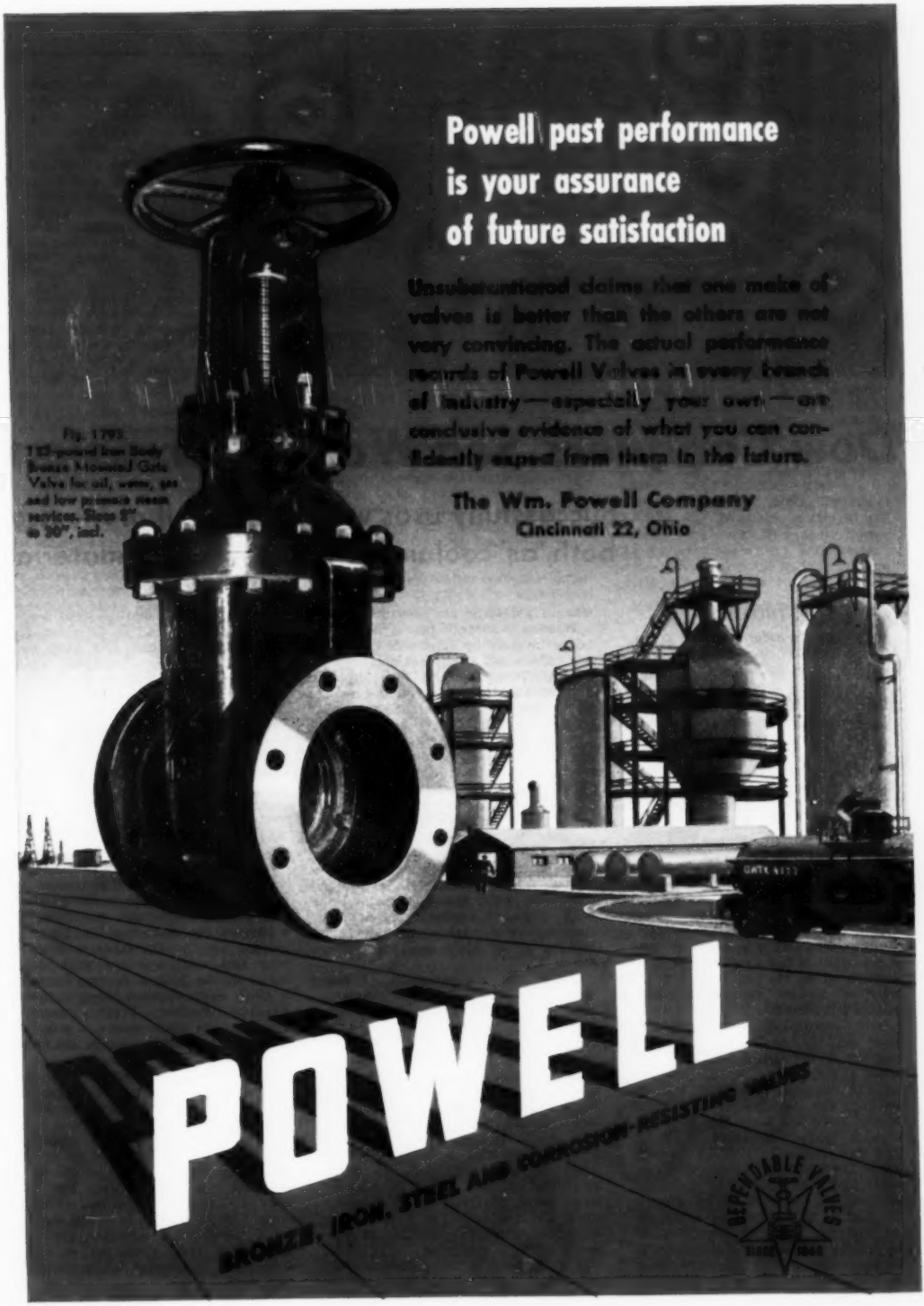
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Fig. 1793
POWELL
BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES
DEPENDABLE VALVES

A WHOLE OCEAN of cooling water is available at the front door of Dow Chemical's Gulf Coast plant. To protect this inlet flume (built of sheet-steel piling) from excessive corrosion, the company uses cathodic protection—shown here in the form of a 200-lb. magnesium anode being removed for inspection

Dow Conquers Sea Water Corrosion

Successfully uses water from Gulf of Mexico both as coolant and process raw material

By D. P. THORNTON, Jr.
Southwestern Editor

SEAWATER as a process cooling medium is not generally looked upon as a satisfactory material, due to its well-known corrosive nature. Yet its use is a great temptation for coastal plants when other water supplies are scarce or brackish, or require extensive treating, and it is being used successfully both as a coolant and a process raw material.

One of the largest volume-users is believed to be Dow Chemical Co. and Ethyl-Dow Chemical Co., in their combined plant at Freeport, Texas. Another is the Dow plant at nearby Velasco. At Freeport alone, where magnesium and bromine are extracted from seawater which also is used as a coolant in the associated organic chemical units, the pumpage is in the order of several hundred thousand gallons per minute.

Dow Chemical does not pretend to know all the answers to the $64 question of preventing seawater corrosion and it has no "secret weapon," but the company has been actively battling the ravages of "Ol' Man Ocean" since the Kure Beach, N. C., bromine extraction plant of Ethyl Dow was erected in 1933-34. In fact, one of the principal reasons why seawater first was selected as a cooling medium was because large quantities had to be handled as a process raw material, anyway, regardless of the cooling medium used elsewhere in the plant. Because of this experience, their methods of handling seawater and some of the things they have learned *not* to do are presented here.

However, several points must be borne in mind by engineers planning an installation using seawater as a coolant. The first, and very important, is that the protective measures used against corrosion to be described in this article are specific for the Freeport installation. They may be generally applicable elsewhere but this cannot be guaranteed.

Second, seawater is not the same everywhere, and evaluating corrosion resistance of samples in a laboratory, possibly using so-called "synthetic seawater," is at best a risky guarantee of success in practical applications. The corrosivity of seawater compared with brackish water, or with dilute or concentrated sodium chloride brines, varies with numerous factors, all of which are not understood.

Third, the concentration of seawater (i.e., salinity) is not constant, especially in coastal regions. This is particularly noticeable along the Texas Coast where the rivers are said to hold the world's record for peak discharge. Salinity at Freeport may vary without much predictability from 30 to 80% of standard Atlantic Ocean salinity. It also varies with depth. The difference in density between seawater and fresh water, 0.026, is quite sufficient to cause stratification; the effect is that of large pools of fresh water floating upon the sea even for considerable distances offshore, moving at the whim of winds and tides.

A final point to remember is that sea water teems with minute lifeforms, from tiny oysters and squirts to barnacles and marine weed seeds. These are too small to filter out for all practical purposes and many materials—wood, for instance—which might readily withstand the chemical corrosion of seawater, can be riddled quickly by these marine organisms and/or require frequent cleaning to remove fouling. These growths not only will gradually restrict sea water mains but large chunks may become detached and plug vital equipment.

How Dow Uses Sea Water

At Freeport, sea water is used for all process cooling where fresh water normally would be used, as coolant in stream condensers for power generation and in respectable quantities as a process raw material. The plant is located on the Intracoastal Waterway and communicates with deep water in the Gulf of Mexico through a 40-ft. deep channel dredged from Freeport Harbor. Fresh seawater comes to the plant intake, a mile inshore of the Harbor mouth, via tidal surge.

The intake basin itself is at the end of a short channel at right angles to the Harbor channel, protected from intrusion of surface waters by a concrete curtain wall so that water is taken from a depth of 20 to 30 ft. No higher salinity would be obtained by going to a greater depth. Preliminary screening to remove sunken logs, large fish and trash is accomplished by a "Grizzly," a bar-type rack of ¾ x 3 in. steel strips set on edge 6 in. apart, suspended below the curtain wall.

The influent receives its second

screening, which removes most of the remaining trash, in conventional "roller-towel" type traveling Link-Belt screens made of bronze with half-inch openings. These screens are continually backwashed into an open trough which returns debris to the Gulf. The water is next lifted through a battery of 70,000 gpm. Worthington submerged-propellor axial-flow pumps to elevation 12.0 ft. above sea level. Each pump discharges into an individual rotating barrel-type screen, the design of which Dow and Link-Belt developed jointly.

This device is a horizontal screened cylinder with one end closed, the sides made of 6-mesh Monel screen mounted on individual wood frames which are carefully insulated by rubber gaskets from the steel framework of the barrel proper to minimize electrolytic corrosion. Seawater enters the open end and is discharged through both sides, the barrels being approximately 50% submerged in the filtrate.

Supported and stationary inside each barrel above the water line is a wide, shallow tray, barely clearing the screens and extending through the open end of the barrel. Filtered sea water sprays located outside the barrel continually backwash the screens into the tray, effectively removing debris with but a remote possibility of any solid matter by-passing the filter. Water from the trays is discarded.

The filtered sea water ranges in temperature over an annual cycle from about 50 to 86° F., with a weighted average variation from year to year of 68 to 77° F. From the screens it goes through a treating basin and thence to two flumes, the largest of which is 2300 ft. long, 12 ft. deep and 18 ft. wide. The sides are sheet steel piling, coated above the water line with hot coal tar enamel. Water velocity is approximately 5 ft. per sec.

The only treatment given sea water is chlorination to inhibit the growth of if not kill off marine organisms. (Another method, obviously impractical here, is to heat the water; maintaining it at 110° F. for four hours is said to be sufficient.) Dow adds the equivalent of 1 to 2 lbs. of chlorine per million lbs. of water. After absorption by organic matter, a residual chlorine content of approximately 0.5 ppm. is obtained.

At convenient intervals along this flume are located the suction basins for the various makes of motor-driven axial-flow pumps supplying coolant to the individual process units. The flume ultimately connects with the surface water disposal system and delivers sea water into the Brazos River, essentially unchanged except for its bromine and magnesium content. The river at this point is strongly affected by tidal action and its waters are normally brackish for several miles up stream from the mouth.

The power plant, very large because of the electrolytic nature of several plant processes, including magnesium and chlorine production, is one of the largest users of cooling water. After passing through its condensers the water is returned to the flume because the 7 to 9° F. temperature rise is quite beneficial to the subsequent bromine extraction process. Used cooling water elsewhere in the plant is discarded to the regular stormwater drains because it is used over a rather wide area, making recollection an expensive matter.

From this brief description it will be noted that there are many opportunities for corrosive attack. These include:

Materials: Mild steel, alloys, pump parts and gasket materials;

Environment: Temperature, oxygen, velocity, alternate wetting and drying, and chemicals; and

Equipment: Structures, piping, condenser boxes and tubes. Normally no shell-side flow of coolant is employed in the plant.

There is still another corrosion condition which, in effect, is caused indirectly by sea water: Protection of above-ground structures and equipment of every kind against salt air. Although not within the scope of this article, suffice it to say that Dow has numerous test racks exposing metals, fabricated articles customarily used out-of-doors and articles testing numerous kinds of protective coatings. Some have been in place for several years and others but a few months.

Measures to Prevent Corrosion

Now to go back and consider what protective measures have been used for the various corrosive conditions.

It has been shown from continuing research, started when the Ethyl-Dow bromine plant at Kure Beach was placed in operation and continued since in a cooperative venture of interested industrial concerns and the International Nickel Co., that there are limiting velocities above which most metals experience increasingly severe corrosive attack from flowing sea water. Velocities and severity can be determined rather accurately by such tests as suspending rotating discs of the material in the water and calculating velocity at the point where the character of the corrosive attack begins or worsens. Variables other than speed should be kept constant and approximate anticipated exposure conditions.

It has been found at Freeport, specifically, that the limiting velocity is 5 ft. per sec. (fps.) for Admiralty and 7.5 fps. for aluminum brass (76 Cu, 22 Zn, 2 Al). Other authorities recommend a maximum of 10 fps. for high-iron cupro-nickel (10 Ni, 0.5-1.0% Fe, 88-89.5 Cu), which Dow now has under test.

For pumps in low-speed low-head service the bodies are cast iron, the quality depending upon service; impellers are Government Bronze G (88 Cu, 10 Sn, 2 Zn). Intermediate heads, 100 to 150 ft. of water, require cast iron casings and Monel impellers. For still higher heads, Ni-Resist or Monel casings, Monel impellers and "K" Monel shafts are used. Some authorities also suggest rubber coatings for both casings and impellers.

Almost every item of plant equipment contacted by seawater has been subjected to extremely severe corrosion or fouling attack. In the early days at Kure Beach a wood flume was used because that had been found adequate for salt brine; it disintegrated in just a few months because of marine borer attacks. Similarly, at Freeport, the most satisfactory methods of protecting wood are to impregnate it with pentachlorphenol or creosote. In floor gratings and similar structures pentachlorphenol has proven satisfactory with respect to rot. An experiment with aluminum gratings now is under way.

Mild steel performs reasonably well when velocities are low, attack increasing rapidly with velocity to around 0.030 in. per year (ipy.) at 10 fps. The corrosion rate is 0.005 ipy. in relatively still water. Above the water-line, where surfaces are alternately wetted and dry, attack is rapid and life short.

Coatings of the heavy coal-tar type have proven reasonably satisfactory for surface structures of mild steel subject to spray or varying water levels in contact with air. However, contours of the equipment and usage must be kept in mind and it is generally necessary to periodically renew these coatings whenever extensive breaks, blisters or spalling off is noted. Underwater application is permissible where equipment can be shut down to permit access but suspected damage is apt to develop.

Cathodic Protection Applied

The most relied-upon protection for steel equipment is the use of sacrificial anodes; cathodic protection. Steel is the most commonly used construction material because of the relatively low cost, compared to the more noble alloys, and normally is readily available in desirable forms. Dow uses large quantities of one of its own products for cathodic protection, magnesium. The range of protective current requirements from magnesium anodes is almost unbelievably wide, varying from 0.1 milliampere (ma.) or less per sq. ft. for well-coated (coal tar) mild steel to 2 to 5 ma. for bare steel in quiet water and up to 125 ma. for bare

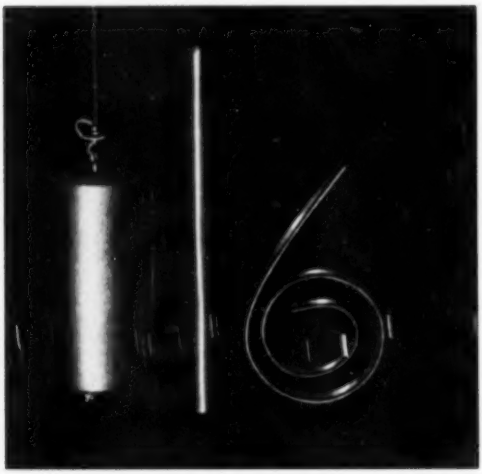


FIG. 1. Three types of commercially-available magnesium anodes: (left to right) 51-lb. cylindrical anode, Galvo-rod and Galvo-line.

FIG. 2. Galvo-slab anode with accessories of bolt, nut and resistor-type washer to control current (middle, right). Dark streak below anode is insulation.

steel in water flowing at 10 fps with turbulence, such as in a condenser water box. In general, the more noble the metal, the less protective current required.

The necessary current and current density has been determined over the plant with the extensive use of test coupons. It is generally conceded that when a potential exists on the steel of minus 0.85 v. with respect to a copper-copper sulfate reference electrode, adequate protection is being obtained.

One characteristic of sea water is quite favorable in cathodic protection, offsetting its more vicious attributes, a protective coating is readily laid down by the action of the current. From electrochemical principles, it will be obvious that there is some electrolysis of sea water, hydrogen being liberated at the cathode (steel) and creating a concentration of hydroxyl, or negative, ions at that point. Since sea water is substantially saturated with respect to calcium and magnesium salts and these materials will precipitate in an alkaline environment, a coating of magnesium hydroxide and calcium carbonate forms on the surface of the metal being protected.

The flume described earlier was protected with cylindrical 200-lb. magnesium anodes initially spaced 32 ft. apart, suspended in the water by a hook welded to the steel core of the anode and attached to steel crossmembers which also serve as pipe racks. The practical value of the protective coating is demonstrated by the spacing now used, 72 ft. Solution potential at mid-point between anodes is only about 100 mv. more positive than opposite the anode, indicating a relatively uniform current distribution.

It is interesting to note that cathode protection of the flume above the water-line is negligible for practical purposes. For this reason it is necessary to keep this portion well-coated with coal-tar enamel, the coating extending only to the water-line.

Protecting Condensers

Cathodic protection is extensively used in the water boxes of condensers at the powerhouse and throughout the process area. This is carried on to the extent that some equipment items are periodically brought off the line principally to replace magnesium anodes as, in the long run, this has been found less expensive than non-corrodable alloys.

The types of magnesium anodes generally used in the plant are shown in Figs. 1 and 2. At the left in Fig. 1 is a 51-lb. 8 in. x 16 in. cylindrical anode, cast around a ¾-in. pipe core to facilitate stringing a number of anodes on a single wire cable. It is used where high currents are needed.

The two other principal types are the "Galvo-line" and "Galvo-rod" anodes, the former being an extruded, ribbon-type anode with a continuous No. 13 iron wire core; it is available in reels and 1000-ft. banded coils. Galvo-rods are made in ½, ¾ and 1-in. standard pipe sizes, contain a No. 13 iron wire core, and are available in lengths up to 20 ft. Both types are used in very confined spaces, high resistivity media and where very high currents are desired for short periods of time.

Fig. 2 shows the 8-in. x 8-in. x 4-in. 15-lb. type, known as the "Galvo-slab," which contains a ¾-in. central pipe core in order that it may be bolted to the structure needing protection. It will better withstand higher water velocities than the 51-lb. anode and is well-adapted to use in confined spaces.

Water-proof plastic is used to seal the bolt-holes and underneath the anode, preventing corrosion of magnesium adjacent to the pipe core and consequent loss of electrical connection. Anode life may be controlled by special resistor-type washers which form an integral part of the bolt assembly. Various resistance ratings are obtainable to give an anode life conforming to varying maintenance shut-down periods.

Several hundred condenser water boxes in the plant are protected with Galvo-slabs, a common arrangement being shown in Fig. 3 where two anodes are placed on the head. Fig. 4 shows how a similar box appears after less than two years service without protection.

Tubes through which sea water flows generally are more severely attacked at the ends. This is due to the great turbulence and high velocities in this region. Also, where Monel boxes and sheets are used, the tube material is less noble, thereby precipitating galvanic corrosion at the tube end. Magnesium, being less noble than either the Monel or the tube metal, will cathodically protect both. However, the center portion is not protected because the current extends only a short distance into the tubes.

Cast iron boxes are less noble than the tubes and box attack is enhanced for this reason. Here, again, magnesium anodes will protect both box and tube ends against sea water but, likewise, the central portion of the

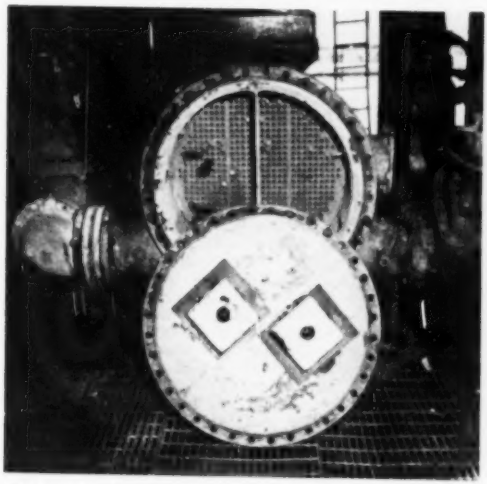


FIG. 3 Condensor water-box with two Galvo-slabs bolted to inside face of cover

FIG. 4 How the box in Fig. 3 would look after two years' service without protection

tubes still is subject to corrosion.

It has not yet been deemed feasible to cathodically protect the full length of the tube for several reasons, largely economic.

Cylindrical anodes of the 51-lb. type are applicable to open tanks containing sea water or similar corrosives as well as to the open-type condenser box. The anodes are suspended as indicated by millivoltmeter survey from steel cables (quiet water) as in Fig. 5 or on rods (to withstand high velocities).

The rotary screen final filter on the sea water intake has its steel structure cathodically protected; likewise the troughs conducting water to the flumes and backwash water to waste. The structure is protected by suspending 51-lb. anodes on individual steel rods and bolting them to the structure so as to withstand the high velocities encountered here. The steel frame of the screen housing proper is protected by attaching Galvo-slabs.

Large-diameter pipe may be protected by attaching anodes internally at frequent intervals as shown in Fig. 6. This pipe, of butt-welded construction, failed along the weld and needed extensive protection. Small pipes also may be protected but the economic feasibility is subject to question.

A substantial part of the laboratory work at Freeport is being devoted to continuing anti-corrosion efforts. By no means is it believed by Dow personnel that the methods which have been described above, or even the experimental work now under way, will prove to be the last word in taking the bite out of sea water.

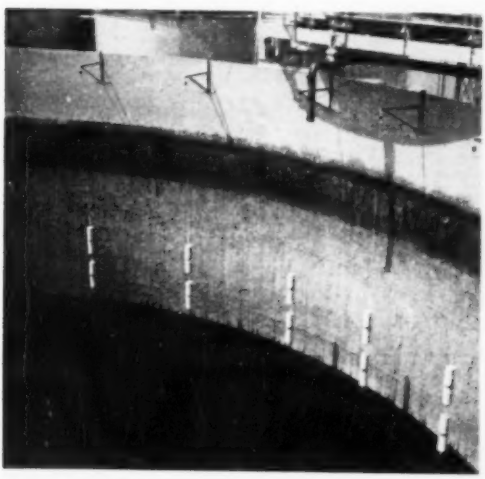


FIG. 5 Anodes suspended on steel cables in an open tank (low water velocities)

FIG. 6 Large diameter pipe protected by anodes rigidly supported to resist high velocities

More Efficient Ethylene Production

Process for vapor phase cracking heavier oil fractions keeps olefin yields high, saturates low

BY CHARLES C. KING and JAMES WARBURTON
M. W. Kellogg Co., New York City*

THE lower olefins, particularly ethylene, have been important and are becoming increasingly more so as feedstocks for numerous chemical manufacturing processes.

Uppermost among the expanding uses of ethylene may be counted the new polyethylene plastic, ethylene glycol, and tetraethyl lead. To meet these demands several plants have been built and more are being constructed to recover ethylene from refinery gases, and in other cases to produce ethylene by the pyrolysis of ethane, propane and heavier hydrocarbons, all potential sources of ethylene.

In the United States, with its large petroleum refining capacity and natural gas supply, ethylene production from waste refinery gases and cracking of ethane and propane has been generally favored over the cracking of heavier normally liquid hydrocarbon fractions. Naphtha and gas oil will become more important as charging stocks for olefin production in our country as the demand for olefins increases beyond that economically recoverable from the available lighter hydrocarbons.

On the other hand in Europe, with the lack of a large and steady supply of refinery gas, chemical manufacturers have chiefly turned to heavier oil fractions such as naphtha and gas oil for olefin production. There have also been incidentally a number of plants in Europe recovering ethylene from coke oven gases. It is doubtful that this latter source is economic in present day competition with petroleum sources.

In the cracking of naphtha and heavier hydrocarbon fractions, it is desired to achieve a high yield of olefins to reduce the consumption of valuable feedstock to the minimum. At the same time it is desired to suppress the formation of saturated gaseous hydrocarbons to make the problem of gas separation as easy as possible.

These two requirements are not completely compatible. Under ordinary conditions of cracking, as the contact time is increased, the formation of ethylene and propylene levels off and finally decreases while the formation of hydrogen and methane continues. This effect is shown in Fig. 1.

If in this case we compare cracking at a contact time of 1.5 sec. with a contact time of 3.5 sec. we find that we increase the yield of ethylene by 20% while there is a corresponding increase in the production of saturates of 58%.

There would be two objections to operating in this case at the higher conversion. First, the cracked gas is more dilute in olefins and therefore requires a larger gas recovery plant for a given tonnage of ethylene. Secondly, a larger quantity of naphtha is degraded to fuel gas per ton of ethylene produced, thereby resulting in a higher net feedstock cost charged against ethylene and propylene. It is for these reasons desirable to find a process which will produce a high yield of olefins while minimizing the production of saturate gases.

Low Coke Formation

In 1946 a pyrolysis pilot plant cracking naphtha and gas oil to produce high yields of olefin was operated in the laboratories of The M. W. Kellogg Co. This process produces high yields of olefins and minimum paraffins with no significant coke formation. Ethylene yields of up to 32 wt.-% from heavy naphtha and up to 26 wt.-% from gas oil have been obtained.

Table 1 — Pyrolysis of Heavy Naphtha by New Steam Cracking Process

Gas Products Wt.-%	Low Conversion	High Conversion
Hydrogen	0.4	0.8
Methane	6.2	10.9
Ethylene	11.8	22.5
Ethane	3.0	2.4
Propylene	10.5	12.0
Propane	0.4	0.4

Table 2—Pyrolysis of Gas Oil by New Steam Cracking Process

Gas Products Wt.-%	Low Conversion	High Conversion
Hydrogen	0.2	0.5
Methane	6.1	9.6
Ethylene	15.0	21.0
Ethane	4.0	3.1
Propylene	10.0	14.6
Propane	0.9	0.6

At the same time the process possesses high flexibility so that a commercial plant may be operated under different conditions to produce the olefins in varying proportions. This latter feature is of importance to the chemical manufacturer whose markets for the chemical derivatives of propylene for example may vary with respect to the market for ethylene derivatives.

A typical commercial plant would be able to produce a range of yields as shown in Table 1 from heavy naphtha and in Table 2 from gas oil. It may be noted that the yields produced from gas oil are very similar to those from naphtha.

The second important feature of the process design is a low temperature recovery system producing ethylene of high purity with high recovery. This low temperature system has proved its ability to remain in continuous operation without periodic shutdown for deicing, a usual procedure in many plants built heretofore. At the same time the process has proven its ability to produce continuously ethylene of 99.9% purity. The recovery of ethylene in the low temperature fractionation system is better than 97%.

Successful Plant in England

Subsequent to the completion of the pilot plant work a plant was designed and built for the Imperial Chemical Industries, Ltd., at Wilton, England. This plant has now been in successful operation for over a year. A second plant is now under construction in Italy.

The principal features of the Kellogg cracking process are (1) vapor phase cracking with superheated steam and (2) recovery of waste heat by quench boilers. The pyrolysis section of the plant is shown in Fig. 2. Naphtha, or gas oil, feed is pumped through the oil preheater and heated to about 1100-1250° F. Some cracking takes place up to this point.

Leaving the oil preheater, the hydrocarbon is joined with 1700° F. superheated steam. The combined steam and oil flow through the transfer line where the major portion of the cracking takes place adiabatically. The steam serves the dual function of supplying the heat of cracking and lowering the partial pressure. Depth of cracking is controlled by adjusting steam and oil ratio.

After cracking, the hot vapors en-

*Mr. King is manager, Chemical Processes Division, and Mr. Warburton is manager, hydrocarbon raw materials section of that division, M. W. Kellogg Co. This article is based on their paper, "Ethylene Production and Recovery," presented at the Oklahoma-State Meeting, American Institute of Chemical Engineers, October 11, 1952 at the University of Tulsa.

ter the quench boiler where high pressure steam is generated. The vapors are quenched to 400—500° F. thereby generating substantially all of the steam required for cracking. From the quench boiler the hydrocarbon and steam flow to the fractionator tower. In the fractionator, 400° F. end point gasoline and lighter material is taken overhead. Heavier material is taken off the botton for fuel oil.

The gas and liquid product overhead from the fractionator then flow to the compression system. The process steam used in the cracking is condensed in the overhead condensing system of the fractionator tower. The condensate is stripped of hydrocarbons by a small amount of low pressure steam.

Fig. 3 depicts the butane fractionation and gas purification section of the plant. The liquid from the compression system is pumped into the debutanizer where debutanized gasoline and butylene-butadiene products are prepared. A small quantity of propane and lighter hydrocarbons entering with the feed are taken overhead and recycled to the compressor.

The raw gasoline produced at this point is a highly aromatic and highly unsaturated product. Its properties are dependent on the depth of cracking. The octane number of the gasoline lies in the range 70-80 CFR-M clear. This gasoline has a high gum content and requires treating before blending into motor gasoline.

The butylene - butadiene product contains less than 5.0% of butanes and 20-50% butadiene depending on the conditions of cracking. Because of its unusual composition this product is also interesting for the production of chemical derivatives.

Flash gas from the high pressure separator in the compression system flows to the caustic scrubbers where the H_2S is removed and then into a water scrubber to remove any entrained caustic. The gas following sulfur removal passes through alumina driers and is dried to a dew point of −30 to −40° F. at operating pressure. The gas from the driers then flows to the acetylene removal system where the acetylene concentration is reduced to 50-60 ppm. The gas is then cooled and fractionated in a depropanizer to remove butylenes.

Acetylene Removal

The details of the acetylene removal step are shown in Fig. 4. Acetylene formed in the cracking is selectively hydrogenated so as to later produce ethylene and propylene products of low acetylene contents. The operation is carried out catalytically under pressure with the hydrogen contained in the process gas accomplishing the hydrogenation. The process gas from the drier is first heated by exchange and then by steam to the range 300-400° F. before entering the acetylene converter. The gas flows through the two converters and intermediate cooler in series. Leaving the final converter the gas is cooled by exchange, water, and refrigerant before entering the depropanizer.

The acetylene converters contain several catalyst beds. Temperatures are maintained by quenching between beds with recycled, cold, treated gas. Temperature control is essential to maintain selectivity in the hydrogenation of the acetylene and the monoolefins. Equipment is provided for the initial reduction and subsequent regeneration of the catalyst with hydrogen.

Fig. 5 shows the flow through the five towers of the low temperature gas fractionation train. The propane and lighter material is separated into tail gas, (methane, and hydrogen with 1.3% ethylene to satisfy the dew point requirements of the gas), ethane product, ethylene product containing 99.8—99.9% ethylene, and propylene product. Two small recycle streams are produced from the ethylene top-

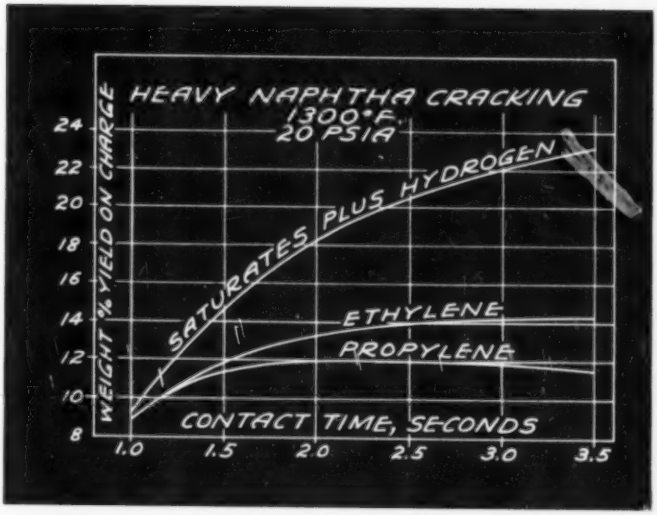


FIG. 1—Conventional heavy naphtha cracking gives unwanted high yields in the saturates compared to rise in olefin yields at longer contact times

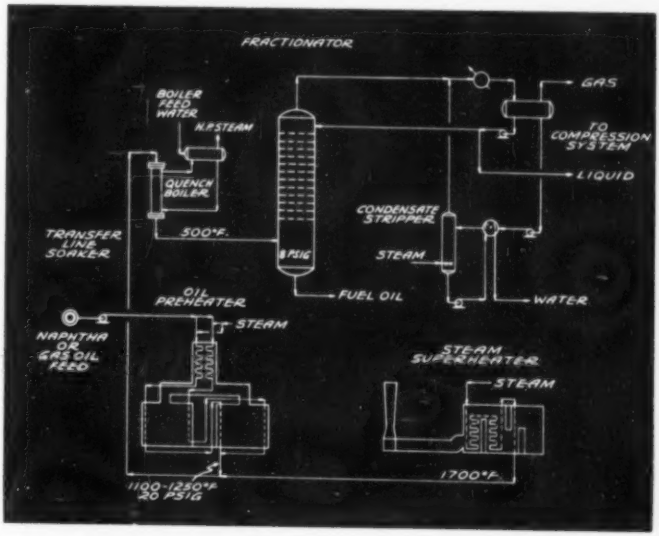


FIG. 2—Pyrolysis section of new cracking process using steam

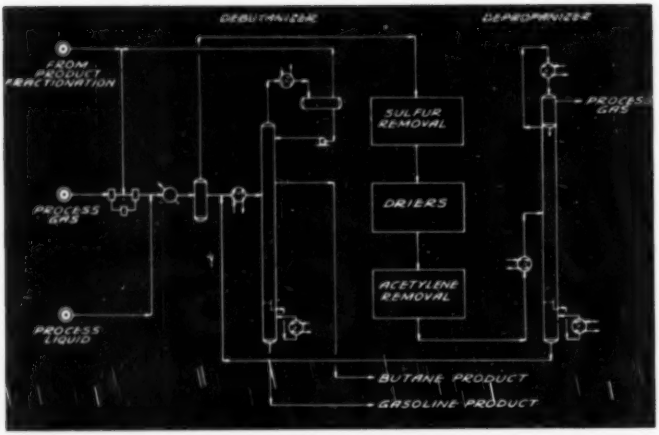


FIG. 3 Butane fractionation and gas purification

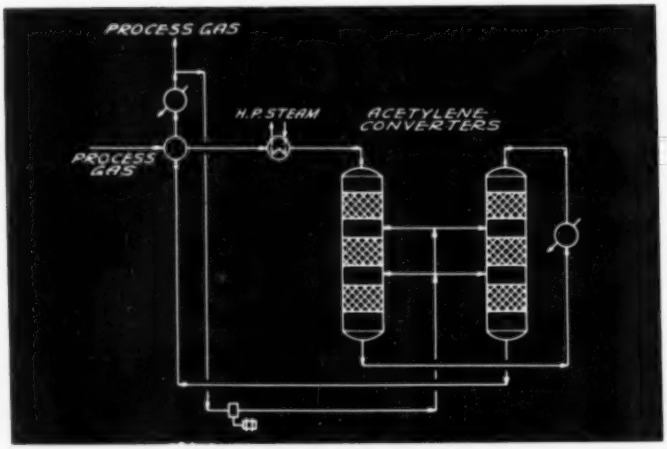


FIG. 4 Acetylene removal system

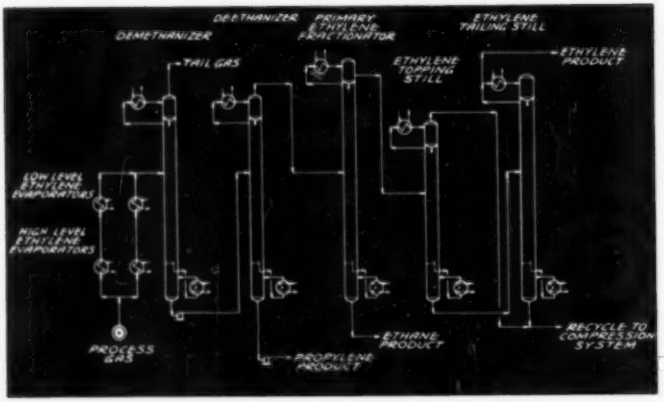


FIG. 5 Product fractionation system

ping still overhead and the ethylene tailing still bottoms.

Demethanizer Not Conventional

The demethanizing column is the heart of this recovery process and it is here that the plant differs from other ethylene recovery plants. The demethanizer is operated at low pressure in the region of 100–150 psi. The feed is chilled to −150° F. and the reflux is condensed at −200 to −210° F. Operating experience has revealed no difficulty with ice formation in this tower. The feed chillers are duplicated and are switched every two to three weeks as necessary when pressure drop builds up across them. Very little reflux is required on the demethanizer, the molal reflux ratio being about 0.24 to 1.

It is of particular interest to note that the propylene product made as a bottoms stream from the deethanizer contains 93-97% propylene. This is another feature of the cracking process showing its high selectivity for olefin production. The propylene product is particularly suitable for chemical derivatives production at high efficiency and does not require any fractionation between propylene and propane.

The ethylene stream from the top of the primary ethylene fractionator contains 98.5% ethylene. This product would be suitable for many applications and in this case the last two towers would not be required. For those applications where a product of 99.5% or higher purity is required, the last two columns serve to perform the cleanup of product from methane and ethane.

Refrigeration is recovered in the ethylene refrigeration system from both the tail gas and ethane product before they are discharged into the fuel gas system. Methane is used as refrigerant in the demethanizer reflux condenser. Ethylene is used as refrigerant in the other reflux condensers shown in this flowsheet.

No reflux pumps are used throughout this section of the plant. Gravity runback of reflux was used on all towers to avoid any possibility of product contamination with gland oil from reflux pumps or loss of product through seals. At the lowest temperatures used in this plant, there are no known pumps in satisfactory commercial operation.

Fig. 6 shows the flow through the propylene refrigeration system. The refrigerant at −48° F. flows from the evaporator to the compressor entering at approximately 1 psig. The gas from the compressor is condensed with water and then subcooled by using it as a source of heat in one of the reboilers. Leaving the subcooler the liquid flows to the flash drum from which the flash liquid flows to the evaporators. The flash gas returns to the compressor entering be-

tween the wheels at the appropriate point in the compressor.

Propylene is used as a refrigerant since it is available as a product from the plant. In areas of high utility costs, an ammonia absorption refrigeration system may be substituted for the propylene system. It is possible to derive all of the heat required to operate an ammonia absorption unit from the condensing overhead vapors of the fractionator tower in the pyrolysis section. Although the capital cost of an ammonia absorption unit will be higher than the compression refrigeration, this first cost is offset by the reduced operating costs in areas of high steam and power costs.

Fig. 7 shows the flow through the ethylene refrigeration system. Ethylene is used as a refrigerant at two levels, —150° F. and about —105° F. This ethylene is used for demethanizer feed chilling, reflux condensing and methane refrigerant condensing. The compression takes place in two centrifugal compressors. The —150° F. ethylene from the low stage evaporator enters the low stage compressor at about 1.0 psig. The discharge gas from the first compressor is mixed with the ethylene from the high level evaporator and the gas from the flash drum and the combined stream enters the high stage compressor at about 43 psig. and —55° F. The discharge gas from the second compressor is cooled first with water, then by exchange with tail gas and ethane product. The resulting 55-60° F. ethylene is then condensed in various heat exchangers and by propylene. The liquid ethylene leaving the condenser is subcooled by exchange with tail gas. The subcooled ethylene is then flashed before flowing to the evaporators.

Fig. 8 shows the flow through the methane refrigeration system. This refrigerant is used only in the demethanizer reflux condenser. The methane refrigeration system is small in relation to the other refrigeration systems and in most plants the flow of refrigerant is not large enough to permit the use of a centrifugal compressor. Therefore, it is necessary to heat the methane gas before it enters the compressor. This methane is heated by exchange with compressor discharge to about —15° F. Leaving the compressor the methane is first cooled with water and then by exchange before being condensed in the ethylene evaporator. The —145° F. methane liquid then flows to the evaporator. Methane for refrigerant can either be obtained from natural gas if it is available or can be made from the demethanizer tail gas. If the latter source of gas is used additional small equipment is required to purge hydrogen and ethylene from the refrigerant makeup.

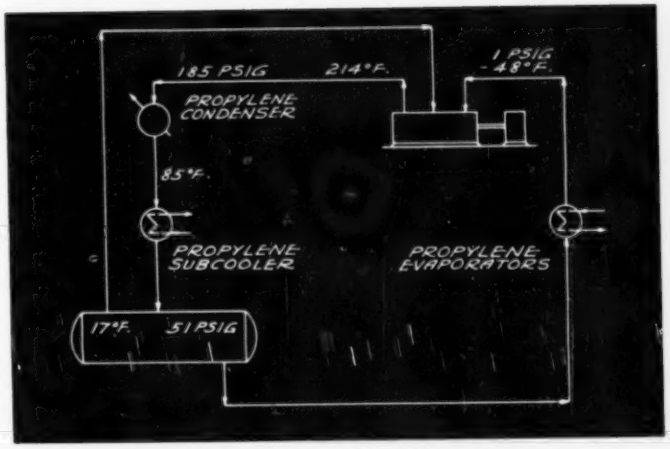


FIG. 6—Propylene refrigeration system

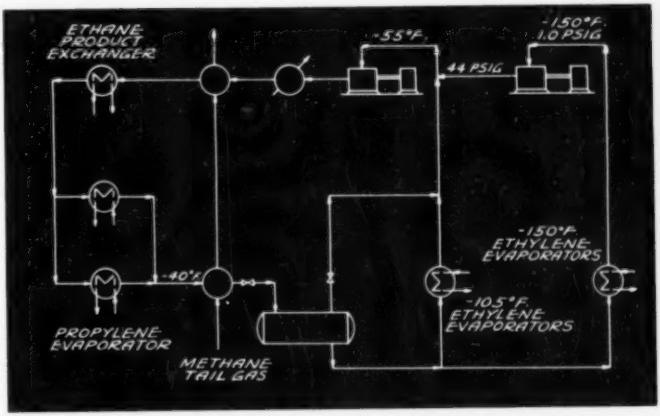


FIG. 7—Ethylene refrigeration system

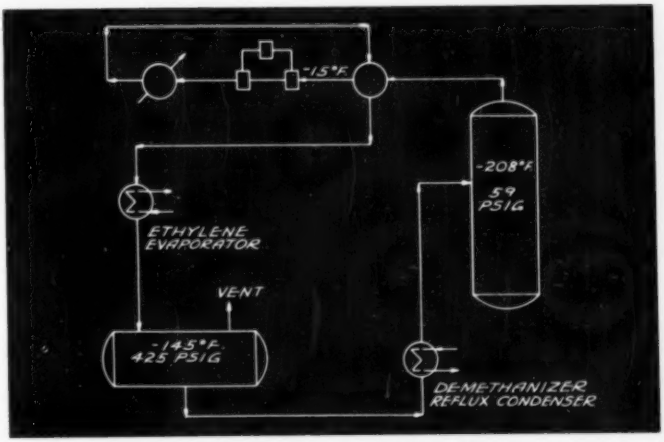


FIG. 8—Methane refrigeration system

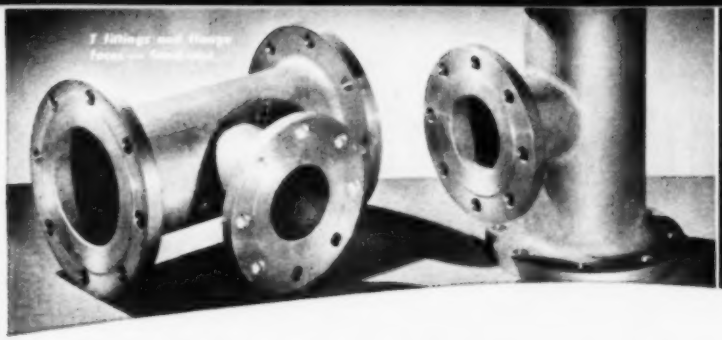
Downington Iron Works, Inc.

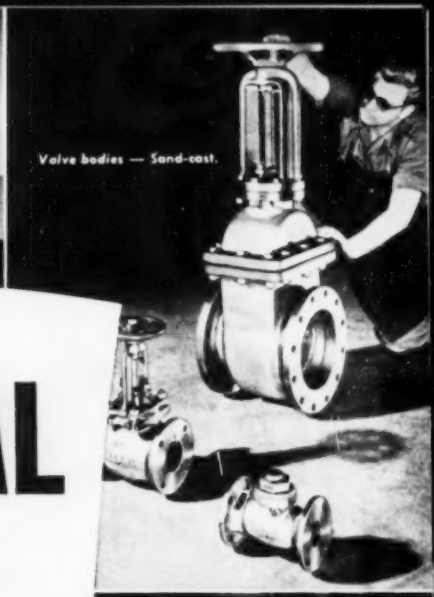
These two exchangers, fabricated by Downington Iron Works, Inc., Downington, Pa., are used in condensing benzene. Ampco Metal Tube sheets are welded to a steel shell and the heads, also made from Ampco Metal, are welded to steel flanges. All welding is done with Ampco-Trode® electrodes. Shell diameter 14". Tube length 10 feet.

Heat Exchangers of

The Whitlock Manufacturing Co.

This 4-pass exchanger was fabricated by The Whitlock Manufacturing Co., Hartford, Connecticut. The service is product cooling, with river water as the cooling medium. Channel cover — steel, lined with Ampco Metal Grade 8. Channel, including flanges — Ampco Metal Grade 8. Tubes — 1323 sq. ft. — $\frac{3}{4}$" OD x 16 BWG x 16'-0" Ampco Metal Grade 8. Physical construction — Whitlock Type 4-ST-4 straight tube floating head (split-ring assembly design). Shell diameter — 27 inches ID.





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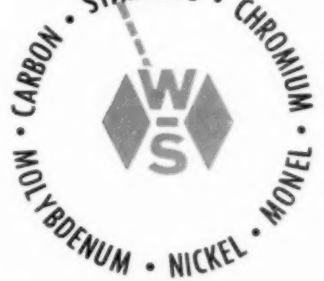

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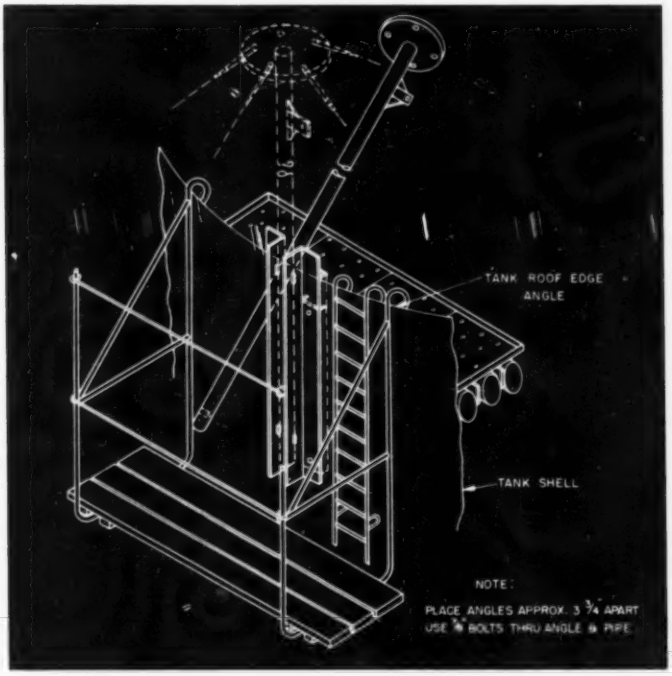

Tank Repairs Simpler with Portable Gin Pole

A PORTABLE gin pole, which can be erected quickly whenever needed, facilitates maintenance and repair work on oil storage tanks at Atlantic Refining Co.'s Philadelphia refinery.

The pole, an 18-ft. length of 3-in. XH pipe, and the method of erection are illustrated in the accompanying drawing and photograph. It is held in place on the edge of the tank shell by two $\frac{7}{8}$-in. bolts put through slots in a pair of angles fastened to the tank wall and holes in the lower end of the pole itself. Details on the various parts of the assembly follow.

The bottom end of the gin pole is plugged with a $2\frac{7}{8}$-in. diameter x $\frac{1}{2}$-in. thick disc, welded into place and pierced with a $\frac{1}{2}$-in. hole for a drain. The pivot holes for mounting the pole are 4 in. and 3 ft., 7 in. (on centers) from the bottom. They are reinforced with 1-in. standard pipe sleeves, $3\frac{1}{2}$-in. long.

A crown piece for guy wires is inserted into the top end of the pole. It is free to rotate. This piece is made of an 11-in. diameter by $\frac{3}{4}$-in. thick disc with a 1-ft. length of 2-in. XH pipe welded to its center. Guy wires are secured to five $1\frac{1}{4}$-in. holes, equally spaced around the periphery of the disc and $1\frac{1}{2}$-in. back from the edge. A $\frac{1}{4}$-in. drain hole is provided in the center of the disc.

A handling "eye" is installed 1 ft. 2 in. down from the top of the pole. It consists of a 4 x 10-in. piece of $\frac{5}{8}$-in. plate, pushed through a slot in the pole and welded into place so that it extends outwardly 6 in. It is reinforced by two triangular gussets of $\frac{5}{8}$-in. plate, 3 in. on a side. The main supports for the gin pole are two 4 x 4 x $\frac{5}{16}$-in. angles, 4 ft., 3 in. long and spaced approximately $3\frac{5}{8}$-in. apart. They each have two $\frac{3}{4}$ x $1\frac{1}{2}$-in. slots in one leg of the angle, to accommodate the $\frac{7}{8}$-in. supporting bolts. One slot is located 9 in. from the bottom; the other is 3 ft., 3 in. above the first one. Short lengths of 2 x 2 x $\frac{1}{4}$ in. angles are welded crosswise (horizontally) on the larger supporting angles, and 4 in. down from the top, to provide means for hanging on the tank wall. The entire supporting angle is bolted to backing-up channels, 4 x 2 x 2 in. and 3 ft. long, in turn welded to the tank shell.

Easy Change Saves Asphalt Sales

A RELATIVELY simple re-arrangement in asphalt processing procedure has resulted in raising crude throughput at the pipestill by about 65 b/d at the Baltimore refinery of Esso Standard Oil Co.

In addition, and perhaps more importantly, it has prevented excess losses of a light oil component in the asphalt and overcome a serious problem in product quality which is believed to have threatened a loss of some 10,000,000 gal./yr. in roofers' flux sales. The improvement, result

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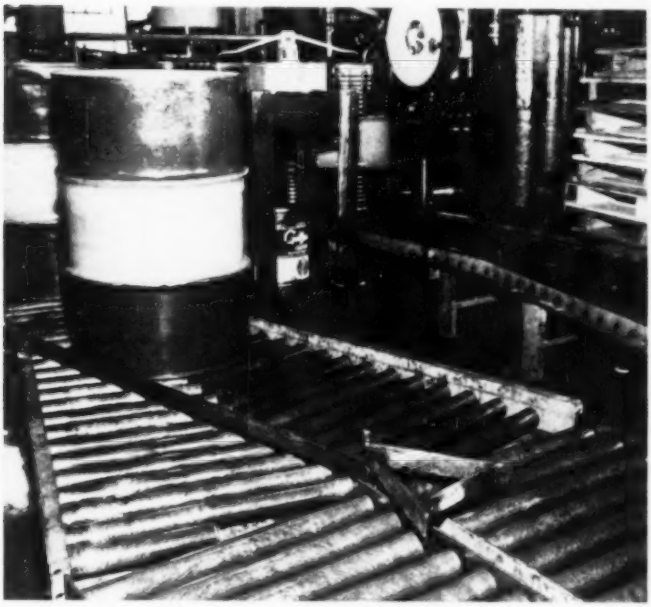
of a suggestion by Samuel Biscoe, a chief operator in the crude distillation division, follows.

Asphaltic base stock to be oxidized for the manufacture of the roofers' flux was made formerly by pumping pipestill bottoms to an oxidizing tank along with 5-8% of the light oil from storage. Because the oil was cold and not pumped in simultaneously with the bottoms, the materials would stratify and it was impossible to obtain a homogeneous mixture. As a result, excessive air was required for the oxidation and 85% of the oil was blown out and lost to slop oils.

Further, in order to maintain correct temperature in the oxidation tank, it was necessary to bypass the pipestill bottoms-to-crude oil heat exchanger so that sufficient heat would remain in the bottoms to offset the cooling effect of the oil component. This caused a definite loss in preheat and attendant loss of crude capacity in the still.

In the new method, the oil, cut as the third sidestream on the pipestill, is combined with the bottoms product and sent directly to the oxidizer. This furnishes the necessary heat for oxidation and eliminates the necessity of bypassing the bottoms-to-crude exchanger. Increased crude capacity has been found to be 23,600 bbls./year.

Elimination of stratification prevented excessive losses of oil to slop and decreased the air requirements at the oxidizer by approximately 50,000,000 cu.ft./year. And finally, product quality was maintained and a loss averted in roofers' flux sales.



"Automatic Switch" Speeds Drums

THE roller conveyor on the 55-gal. drum filling line in the Package Department of Gulf Oil Corp.'s Philadelphia refinery splits into two lanes as it leaves the scale. This helps speed up shifting loaded drums onto pallets and thence to warehouse storage or directly to delivery.

Normally, the operator would have to guide the drum to the proper lane. This operation is now done automatically by a simple "switch," or diverging bar, illustrated in the accompanying photograph. Made of flat stock in the form of a long bar welded to a small triangle, the switch is pivotally mounted with the apex of the triangle rotating at the mid-point and the head end of the double lane conveyor.

As a drum rolls off the filling scale platform onto the track, it strikes the triangular section, throwing the flat bar guide to the opposite side so that the next drum is guided to the other roller lane. This operation then repeats alternately as each new drum comes off the filler.

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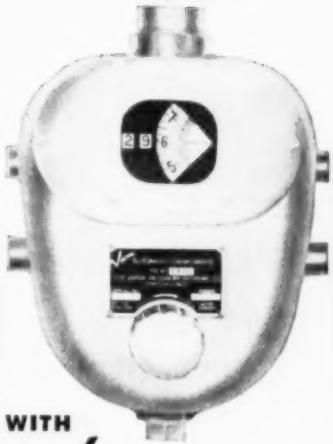

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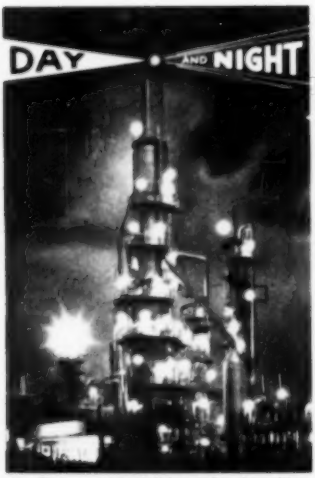

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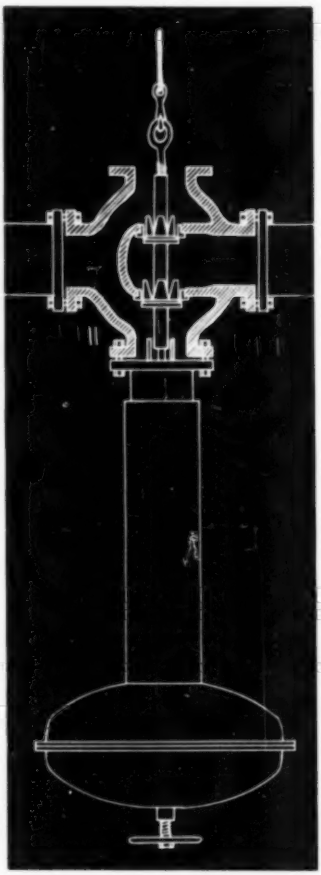

Safety in Dismantling Inverted Control Valves

By JAMES W. ROSS*

A NUMBER of large size (8-in.) control valves in the Cleves, Ohio, refinery of Gulf Refining Co. have been installed in an upside-down position for ease of access to the hand jack screws in the diaphragm case.

It has always been very awkward to dismantle these valves for cleaning. The usual procedure was to have a yoke clamped around the bonnet, with a sling going around the outside of the valve body to an overhead chain hoist, to lower the top-work and the inner valve to the floor.

This was dangerous to personnel, who had to stand partly underneath the valve in order to guide the traveling load and prevent damage to the plugs and seats. Re-assembly was even more critical, because with the load suspended in this manner it was quite difficult to maintain alignment in guiding the plugs into the seat rings. As a solution, the instrument department came up with the method shown in the sketch.

The valve plugs being made for reversibility, the "lower" guide (actually on top in the installation) is threaded, so an eyebolt was made with threads to fit, of such a size as to pass easily through the valve seat rings. Now the inner valve and top-work assembly can be lowered or raised smoothly and confidently right through the middle of the valve body, with greatly reduced hazard to personnel and equipment, and with an attendant saving in time and effort.

*Mr. Ross is Instrument Man No. 1, Gulf Refining Co., Cleves, Ohio.

How to Repair Leaks On Ammonia Lines

NIPPLES and connections on ammonia lines will frequently corrode to such an extent that they will leak, usually below the insulation, making it difficult to prepare the equipment for welding.

A simple method of repairing developed at one eastern refinery is as follows: First, reduce the pressure on the system at the particular section where the leak has occurred. Second, cut the leaking connection and place an ordinary cork of the proper size in the opening to prevent fumes from escaping. Third, weld a two-inch, swaged nipple to the main line, over the entire old nipple. Fourth, remove the cork and make the new connection to the small end of the swaged nipple.

Keep 'em Coming!

Thanks a million to those of you who have already contributed short items to this—YOUR Plant Practices section. The response to our invitation to submit material has been swell. Let's hear from more of you. Send us your own valuable maintenance or operating shortcut ideas and we'll dress them up, if necessary, for publication.

Or maybe you haven't any ideas of your own, but instead you have some problem, some headache on the job that just won't give out with an answer. Write us anyway. We'll print your troubles and solicit an answer for you from one of the other thousands of readers.

Plant Practices Editor
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1213 West Third St.
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Direct Titration of Gasoline Mercaptans

By GEORGE E. MAPSTONE*

DIRECT titration methods are always preferable to back titration methods on account of their generally greater accuracy and simplicity. The latter factor is of prime importance when unqualified staff people have to carry out the analysis.

The following method has been used in the author's laboratory for several years and has proved itself to be more sensitive than the various methods based on the "copper number" of the gasoline, as well as being simpler to conduct.[1]

It involves the titration of the mercaptans with standard silver nitrate solution in the presence of an amine to prevent the precipitation of silver oxide, and an alkaline extractant solution. A solutizer is added to increase the solubility of the mercaptans in the aqueous phase. Sodium nitroprusside (nitroso ferricyanide) is used as an internal indicator. Reagents used are as follows:

1—Pyridine (denaturant grade is suitable).

2—Sodium cresylate solution, prepared by dissolving 15 ml. of redistilled hydrogen sulfide- and mercaptan-free cresylic acid in 85 ml. of 10% caustic soda solution.

3—Butyl or amyl alcohol (commercial grade is suitable).

4—Sodium nitroprusside, freshly prepared solution, approximately 0.5%.

5—Standard silver nitrate solution, 0.05N.

6—Fuller's earth.

Procedure

Pipette 100 ml. or other suitable volume of the hydrogen sulfide-free gasoline into a 250 ml. flask. Add 1 ml. each of pyridine, sodium cresylate solution, and sodium nitroprusside solution. Add 10 ml. of the alcohol, which acts as the solutizer.

Shake well and titrate with the standard silver nitrate solution until the purple color of the lower layer disappears. Add a further 0.5 to 1 ml. of the nitroprusside solution and, if the purple color reappears, continue the titration. In this manner check the end point until the addition of further nitroprusside fails to regenerate the color. This seldom requires a second test but the indicator is slowly decomposed by the caustic soda and, if too much time has been spent carrying out the titration, it will have all been decomposed before the true end point has been reached.

If much silver mercaptide is precipitated during the titration, it may interfere with the observation of the color of the solution. It may be coagulated by adding a pinch of the fuller's earth.

Calculation of Results

Mercaptan content can then be calculated by the following equation:

$$M = \frac{3.2 \times N \times V}{c \times S}$$

where:

M = mercaptan sulfur content of the sample as wt.-%.
N = normality of the silver nitrate solution.
V = ml. of silver nitrate solution used.
c = ml. of gasoline sample used.
S = specific gravity of the gasoline at the temperature of measurement.

Hydrogen sulfide must be removed if present in the original sample. This can be effected by washing with a 5% solution of cadmium sulfate in 1N sulfuric acid. If the acid is weaker than this, some mercaptan can be removed at the same time.[2]

*Mr. Mapstone, a previous contributor to these columns, was associated with the National Oil Pty. Ltd., Glen Davis, New South Wales, Australia, until about a year ago. At present, he is with C.S.I.R.O. Coal Research Station, Chatswood, New South Wales.

(1) Mapstone, G. E., *Anal. Chem. Inst. J. & Proc.*, Vol. 15, 238-241 (1948).
(2) Mapstone, G. E., *Anal. Chem. Inst. J. & Proc.*, Vol. 13, 373-377 (1946).

IDEAS — Wanted!

Chemists, technicians, inspectors—send in your own contributions on "how we do it in our lab". Possible subjects might include gadgets, shortcut procedure, safety ideas, and the like.

Please include sketches, charts, diagrams, or photographs where possible. Don't worry about the actual writing. We can dress it up if necessary. Send your ideas to:

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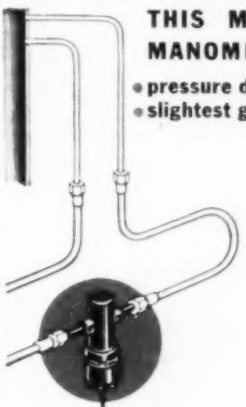

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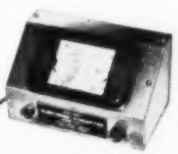

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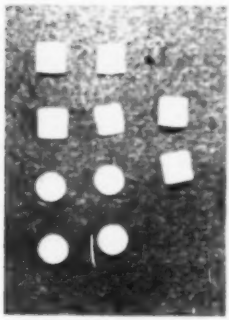
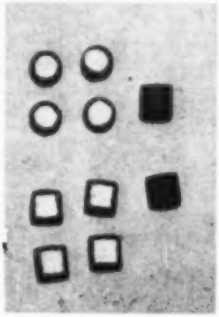
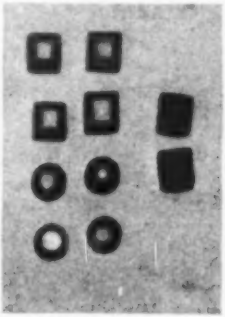
By Peter J. Gaylor, Patent Attorney, Gaylor, Cifelli & Jurick, Newark, N. J.



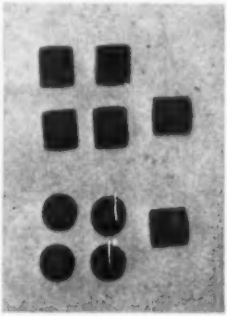
1 Unimpregnated alumina pellets halved (left) and whole (right)



2 Surface impregnated (Cr_2O_3), before removal of any binder



3 Shell impregnated (Cr_2O_3), after removal of binder from outer shell



4 Completely impregnated (Cr_2O_3)

EXTENT OF IMPREGNATION of various alumina catalyst pellets, as controlled by non-removal (2), partial removal (3) and complete removal (4) of binder prior to impregnation (Phillips Petroleum Co.—U. S. 2,606,159)

Produce Catalysts of Superior Activity By Controlling Depth of Impregnation

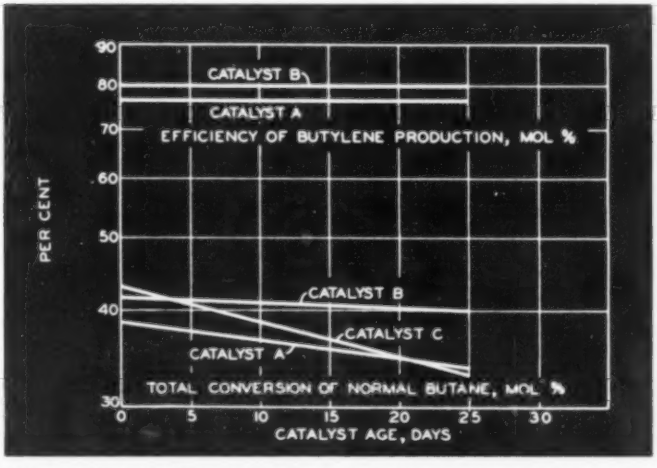
THE superiority of pelleted catalysts is well recognized in the chemical and petroleum fields, and activated alumina pellets are widely employed at present in reforming, platforming, dehydrogenation and similar operations.

These catalysts are usually prepared by finely grinding precipitated alumina gel together with one or more oxide promoters, mixing with a binder (such as hydrogenated corn oil, hydrogenated peanut oil, graphite or aluminum stearate), and calcining. The binders not only facilitate formation of coherent pellets but also act as lubricants for the pelleting machine. During the calcination (which may be in the presence of oxygen) the binder and any residual moisture are removed from the pellets.

In U. S. Patent 2,606,159, Phillips Petroleum Co. claims to have discovered that a catalyst of superior activity is obtained when the minor component or promoter is concentrated at or near the surface of the catalyst pellet and the inner part of the pellet is substantially free of the minor component. In the patented method, the alumina pellets are calcined so that only 50-75% of the binder is removed. Since the combustion of the binder begins at the surface of the pellet and progresses inwardly, interruption of the combustion leaves a core of binder in the inner part of the pellet, so that the outer part of the pellet is rendered relatively non-porous. This may be accomplished by heating the pellets in a furnace through which an oxygen-containing gas is passed at 400°-1100° F. for a contact time of 3-15 min.

After the combustion, the pellets are impregnated with the promoter or minor component metal salt solution by spraying, dipping, etc. Ammonium molybdate is preferred as the impregnating solution when preparing molybdenum oxide shell-type catalyst, while platinic chloride and silver nitrate are preferred if metals are to be the impregnants. The thus-impregnated pellets then are ignited at 400°-1100° F. to remove water, to convert the dissolved salt to oxide, and to remove the rest of the binder.

The series of photographs above shows various forms of alumina pellets. Photo "1" shows unimpregnated pellets, some of which are halved transversely, some longitudinally. Photo "2" shows pellets like those of "1" which were dipped in chromic acid solution before burning out any of the binder. Very little impregnation is observable. Photo "3" shows the pellets of "1" treated according to the patent, wherein 50-75% of the binder was burned out prior to impregnation, while photo "4" depicts pellets from which all of the binder was burned out prior to impregnation. The accompanying chart shows the



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REFRACTORY LININGS

efficiency of butylene production in butane dehydrogenation, using the various catalysts mentioned. Catalyst A is completely impregnated as in photo "4". Catalyst B is shell-impregnated as in photo 3. Catalyst C is impregnated throughout the pellet and contains the same amount of chromium oxide as Catalyst B. It is apparent that the shell-impregnated catalyst shows somewhat higher efficiency and appreciably better retention of total conversion.

Patents Issued in September

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for September 2, 9, 16, 23, and 30, 1952. Vol. 662, Nos. 1-5.

PROCESSES

Catalysts

2,614,745 (Universal Oil Products Co.) Preparation of an alumina-platinum-combined halogen catalyst.

Conversions

2,609,331 (Sinclair Refining Co.) Pyrolytic conversion of oil shale.

2,609,332 (Lummus Co.) Continuous conversion of heavy residual oil.

2,610,944 (Standard Oil Development Co.) Carbonizing carbonaceous solids in fluidized bed.

2,611,736 (Universal Oil Products Co.) Reforming process and halogen-alumina catalyst containing Pt.

2,611,737 (Sinclair Refining Co.) Process for the preparation of hydrocarbon cracking stocks for catalytic cracking.

2,611,738 (Universal Oil Products Co.) Hydrocarbon conversion activated silica hydrogel catalyst and process.

2,611,789 (Shell Development Co.) Production of alpha olefins by catalytically cracking paraffins over active carbide.

2,612,531 (Standard Oil Development Co.) Polymerization of olefins and the alkylation of polymer.

Hydrocarbon Synthesis

2,609,345 (Gulf Research & Development Co.) Regeneration of a fixed-bed Fischer-Tropsch catalyst.

2,609,382 (Phillips Petroleum Co.) Production of hydrocarbon synthesis gas.

2,610,200 (Phillips Petroleum Co.) Synthesis of hydrocarbons from CO and H_2.

2,610,975 (Standard Oil Development Co.) Process for the synthesis of hydrocarbons from carbon monoxide and hydrogen with an iron type catalyst.

2,610,976 (Standard Oil Development Co.) Hydrocarbon synthesis using fluidized system.

2,612,512 (Phillips Petroleum Co.) Process for the synthesis of hydrocarbons from carbon monoxide and hydrogen by means of a fluidized fixed-bed.

Refining

2,609,959 (Hydrocarbon Research, Inc.) Mass diffusion process for separating gases.

2,609,276 (Standard Oil Development Co.) Liquid-liquid extraction process and tower.

2,609,277 (Phillips Petroleum Co.) Contacting of immiscible liquids.

2,609,333 (Phillips Petroleum Co.) Azeo-extractive distillation of cyclopentane and neohexane using methyl formate.

2,609,335 (Eastman Kodak Co.) Fractional distillation process and apparatus.

2,609,887 (Union Oil Co. of California) Adsorption process and apparatus for separating gaseous mixtures.

2,609,925 (Socony-Vacuum Oil Co.) Process for separation of partly dried gel particles.

2,610,141 (Standard Oil Development Co.) Extractive distillation process.

2,610,697 (Ryalls Tanks, Inc.) Gas and liquid separator apparatus.

2,610,696 (Bryalls, Tanks, Inc.) Emulsion treater.
2,610,703 (Phillips Petroleum Co.) Continuous adsorption process for separating low-boiling hydrocarbon gases.
2,610,704 (Standard Oil Development Co.) Separation of ethane and ethylene by extractive distillation using acetone or furfural.
2,610,836 (Standard Oil Development Co.) Rotating plate-mixing device.
2,610,942 (Standard Oil Development Co.) Extraction of aromatics with phenol and silicone polymer oil.
2,610,943 (Atlantic Refining Co.) Solvent fractionation of wax-containing mixtures.
2,611,735 (Sinclair Refining Co.) Process for removing metal from crude petroleum oils with fluosulfonic acid.
2,612,464 (Standard Oil Co. (Indiana)) Process and system for treating hydrocarbon oil with liquid hydrogen fluoride.
2,612,465 (Texaco Development Corp.) Separation of oil and wax by continuous filtration.
2,612,466 (Texaco Development Corp.) Continuous vacuum filtration.

PRODUCTS

Chemicals

2,609,328 (Standard Oil Development Co.) Dye manufacture.
2,609,244 (Standard Oil Co. (Indiana)) Process for producing CO-free hydrogen.
2,609,359 (Standard Oil Development Co.) Copolymers of a polyene, an arene and an aliphatic unsaturated aromatic hydrocarbon.
2,609,362 (Phillips Petroleum Co.) Emulsion polymerization in systems containing an organic hydroperoxide.
2,609,363 (Standard Oil Development Co.) Copolymerization of divinyl benzene and isobutylene.
2,609,366 (Phillips Petroleum Co.) Use of methanol or ethanol as peptizer.
2,609,375 (Standard Oil Co. (Indiana)) Alkylation of thiophene.
2,609,382 (Lubrizol Corporation) Nitrobenzyl thiophosphate esters.
2,609,383 (Phillips Petroleum Co.) Oxidation of hydrocarbons to cresols(ols) and vicinal epoxide.
2,609,400 (Standard Oil Development Co.) Modified wash-acid isopropanol process.
2,609,401 (Purdue Research Foundation) Nitration of saturated aliphatic hydrocarbons.
2,609,406 (Phillips Petroleum Co.) Production of ammonia.
2,610,561 (Union Oil Co. of Calif.) Modified oil-polymer drying oils.
2,610,166 (Shell Development Co.) Treatment of equipment to remove polymeric deposits.
2,610,178 (American Cyanamid Co.) Use of petroleum sulfonates in preparation of resin-ammonium condensation products in lead form.
2,610,182 (Standard Oil Development Co.) Hydrocarbon thiophosphoric acid salts of thiadine and certain homologues.
2,610,183 (The Texas Co.) 3-substituted derivative of 2,3-dihydrothianaphthene-1-dioxide.
2,610,191 (California Research Corp.) Tetracarboxy phenyl thiophene and method of making same.
2,610,192 (Phillips Petroleum Co.) Method for grinding methyl sulfolenes.
2,610,195 (Shell Development Co.) Cyclic dihydrogen organic compounds.
2,610,197 (Union Oil Co. of Calif.) Separating organic acids with aqueous borate extractant.
2,610,201 (California Research Corp.) Neryl petrolates.
2,610,206 (Socony-Vacuum Oil Co.) Alkylamino dicarboxylic ester composition.
2,610,209 (Sun Oil Co.) Solvent extraction of naphthenic acids.
2,610,211 (California Research Corp.) Preparation of benzene monocarboxylic acids.
2,610,215 (Selvay & Cie) Process of manufacturing trichloroethylene and perchloroethylene by chlorinating acetylene.
2,610,950 (California Research Corp.) Detergent containing Na stearate, tetrasodium pyrophosphate and alkyl benzene.
2,610,974 (Sinclair Refining Co.) Wax acids.
2,610,977 (Standard Oil Development Co.) Recovery of alcohols from hydrocarbon oils.
2,610,981 (Phillips Petroleum Co.) Production of thiols and thioethers.
2,611,740 (Shell Development Co.) Distillation of furfural.
2,611,750 (Sun Oil Co.) Thermally hardened petrous residuum solid.
2,611,751 (Standard Oil Development Co.) Anti-tack agent (urea or Na sulfonate emulsion).
2,611,760 (Universal Oil Products Co.) Condensation product of formaldehyde with a copolymer of a vinyl aromatic compound and an aliphatic mono-olefin and process of making same.
2,611,764 (Universal Oil Products Co.) Copolymers of oxidized isobutylene fractions with hydrocarbons.
2,611,766 (Standard Oil Development Co.) Process for the formation of a sulfurized base-treated aliphatic hydrocarbon.
2,611,783 (Shell Research & Development Co.) Synthesis of esters of thiaddimethylvaleric acid.
2,611,788 (Universal Oil Products Co.) Modification of drying oils.
2,612,467 (Standard Oil Development Co.) Extractive distillation of ethanol contaminated by n-propanol.
2,612,468 (Standard Oil Development Co.) Extractive distillation with salt solutions.
2,612,488 (Standard Oil Development Co.) Stabilization of organic materials with aryl polyphosphite condensation product.
2,612,491 (Shell Development Co.) Mixed polycarboxylic acid esters of alkylidene glycols and polymers thereof.
2,612,493 (Standard Oil Development Co.) Nonconjugated higher diolefin homopolymers.
2,612,505 (Socony-Vacuum Oil Co.) Ammonolyl derivatives of thiophene.
2,612,511 (Socony-Vacuum Oil Co.) Preparation of hexanekexadiolates.
2,612,515 (Standard Oil Development Co.) Use of phosphites in esterification reaction of synthetic alcohols.
2,612,526 (Union Oil Co. of Calif.) Preparation of carboxylic acids from carbon monoxide and olefins.
2,612,529 (Socony-Vacuum Oil Co., Inc.) Higher molecular weight fluorine-containing compounds.
2,612,530 (Shell Development Co.) Production of methanol chloride.

Fuels

2,609,278 (Standard Oil Development Co.) Turbojet fuel containing cumene hydroperoxide.
2,609,282 (United Engineers & Constructors Inc.) Apparatus and method for handling of liquefied normally gaseous materials.
2,609,283 (Hydrocarbon Research, Inc.) Conversion of carbonaceous materials into a fuel gas.
2,610,112 (Universal Oil Products Co.) Sour removal process containing copper chelate chlorohydrocarbon.
2,610,113 (U. S. of America, Sec. of Army) Moisture control of hydrocarbon gel solidified fuel using alginic acid.
2,610,114 (U. S. of America, Sec. of Army) Solidification of liquid fuel using polymeric salts.
2,610,421 (Union Carbide and Carbon Co.) Process of and apparatus for metering a liquefied gas.
2,611,329 (Harry A. Kraeling) Gasoline or other liquid dispensing means.
2,611,512 (Pazmay & Krazinski) Explosion-proof gasoline tank.
2,612,439 (Standard Oil Development Co.) Diesel fuel containing sulfur, calcium petroleum sulfonate and alkyl phenol sulfide.

Lubricants

2,609,342 (Socony-Vacuum Oil Co., Inc.) Grease or glycerin lubricant containing MoS_2, etc.
2,609,343 (Saunders Murphy, Jr.) Phenothiazine oxidation inhibitor for diester lubricating oils.
2,610,150 (O'Neil) Wax-metal powder lubricating composition.
2,610,151 (Standard Oil Development Co.) Noncorrosive oil compositions containing petroleum sulfonate and stabilizer.
2,610,930 (The Texas Co.) Lithium soap grease containing basic alkaline earth metal sulfonate.
2,610,947 (Standard Oil Development Co.) Lubricating grease containing Cammizaro condensation products.
2,610,948 (Standard Oil Development Co.) Synthetic lubricating compositions containing OXO products.
2,610,962 (The Texas Co.) Manufacture of magnesium salts of high molecular weight alkylated hydroxy aromatic compounds and their use in lubricating oils.
2,611,742-6 (Aluminum Company of America) Lubrication composition containing BF_3 treated fatty compounds, etc.
2,612,472 (Standard Oil Development Co.) Lubricating grease containing thio ether soap.
2,612,473 (Standard Oil Development Co.) Lubricating grease containing soap with ether linkage.

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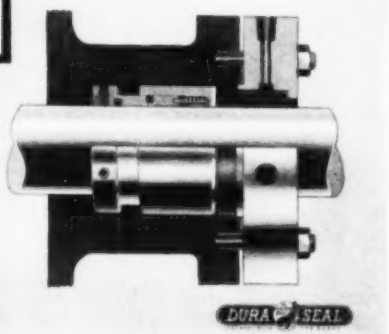

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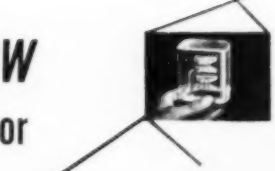

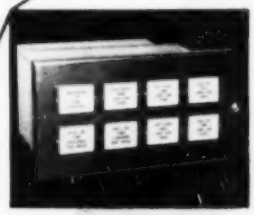

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Patents

2,612,474 (Cities Service Research and Development Co.) Phenol formaldehyde resol base dispersion products in (tricresyl) phosphate medium.

2,612,475 (Standard Oil Development Co.) Increasing oil additive comprising homopolymer of unsat. ester.

Specialties

2,609,364 (Standard Oil Development Co.) Process for preparing asphalt coated aggregate (treated with methyl trichlorosilane).

2,610,116 (Phillips Petroleum Co.) Herbicide and defoliant (furfural compound).

2,610,925 (U. S. of America—Sec. of the Interior) Rubber reclaiming oil (crude oil fraction).

2,610,949 (Stowa) Hydraulic fluid comprising organo silico fluoride.

2,610,956 (National Bank and Trust Co.) Method of mixing polyethylene with asphalt bitumens.

2,611,728-9 (Standard Oil Development Co.) Insecticidal compositions containing substituted esters of di-ethyl dithiophosphoric acid.

2,611,734 (Gulf Research & Development Co.) Production of high m. p. and high I. s. waxes.

2,612,477 (Shell Development Co.) Emulsifier compositions containing salt of organic acid containing —SO$_3$H group.

Miscellaneous

2,609,966 (Standard Oil Development Co.) Fluid sampling equipment.

2,609,118 (Shell Development Co.) Aircraft fuel tank.

2,609,140 (Shell Development Co.) Radial compressor with auxiliary bladewheel.

Re 23,545 (The Texas Co.) Concentric pipe insulator and spacer.

2,609,689 (Phillips Petroleum Co.) Magnetic change-over valve.

2,609,964 (American Pipe & Steel Corp.) Recess mounting for valves and fittings for liquefied petroleum gas containers.

2,610,899 (Kansas City Testing Laboratory) Pipeline transportation of water soluble granular materials and light hydrocarbons.

2,610,900-1 (Kansas City Testing Laboratory) Pipeline transportation of clay gel and petroleum products.

2,611,268 (National Research Corp.) Velocity metering of gas flow.

2,611,511 (Chicago Bridge & Iron Co.) Method of preventing evaporation loss and apparatus therefor.

EQUIPMENT

Processing, general

2,609,069 (Hydrocarbon Research, Inc.)—Gas separation apparatus using the principle of mass diffusion.

2,609,276 (Standard Oil Development Co.)—Liquid-liquid solvent extraction tower and process.

2,609,332 (The Lummus Co.)—Continuous contact coking system.

2,609,334 (E. du Pont de Nemours & Co.)—Falling film fractionator.

2,609,335 (Eastman Kodak Co.)—Fractional distillation apparatus and process.

2,609,887 (Union Oil Co. of California)—Adsorption unit and process.

2,610,108 (Standard Oil Development Co.)—Liquid-liquid extraction tower.

2,611,457 & 2,611,506 (Glitsch Engrg. Co.)—Fractionator trays.

2,611,499 (Selas Corp. of America)—Apparatus for separating immiscible liquids by means of a membrane.

2,612,360 (C. F. Braun & Co.)—Bubble cap and hold-down device.

Catalytic Reactors

2,609,248 (Standard Oil Development Co.)—Baffle for catalyst carrying conduit.

2,610,093 (Sun Oil Co.)—Pneumatic lift conduit for granular materials.

2,610,909 (Universal Oil Products Co.)—Catalytic contact chamber.

2,611,684 (Phillips Petroleum Co.)—Catalyst support in a contact chamber.

2,611,685 (Standard Oil Development Co.)—Fluid distributor for vessels.

2,612,423 (Standard Oil Development Co.)—Annular stripper modification.

2,612,437 (Standard Oil Development Co.)—Catalyst reaction vessel.

2,612,438 (Standard Oil Development Co.)—Fluidized solids contacting unit.

Pumps & Compressors

2,609,140 (Shell Development Co.)—Radial compressor with auxiliary bladewheel.

2,609,141 (Sulzer Freres, Societe Anonyme, Winterthur, Switzerland)—Centrifugal compressor.

2,609,684 (M. W. Kellogg Co.)—Apparatus & method for pumping volatile liquids.
2,611,322 (W. H. Martin)—Rotary, positive displacement pump with radial inlet and outlet.
2,611,323 (Harold D. Digney)—Gear pump.
2,612,110 (Carl J. Delegard)—Rotary, positive displacement pump and motor.
2,612,116 (Preston D. Lawther, Sr.)—Pump lubrication system.

Valves & Fittings

2,609,174 (Joseph Hecker)—Plug valve.
2,609,175 (Dunkirk Mfg. Co.)—Check valve.
2,609,669 (Phillips Petroleum Co.)—Magnetic change-over valve for liquefied gases.
2,610,820 (Edward Valves, Inc.)—Valve bonnet structure.
2,610,870 (Chiksan Co.)—Union with pressure responsive seal.
2,611,388 (Chester B. Talley)—Pressure control valve.
2,611,390 (Shell Development Co.)—Automatic pressure control valve.
2,611,575 (Jenkins Bros.)—Quick acting gate valve.
2,611,576 (Phillips Petroleum Co.)—Positive closure plug valve.
2,612,340 (Milton P. Laurer)—Rotary plug valve.
2,612,341 (G. P. Bridgefield, Mexico City, Mexico)—Axially movable rotary plug.

Instruments

2,608,866 (Standard Oil Development Co.)—Fluid sampling equipment.
2,609,143 (George R. Schultz)—Electronic computer for addition and subtraction.
2,609,687 (Harry L. Coleman)—Adjustable sight level gage.
2,609,831 (Automatic Temperature Control Co.)—Pressure flowmeter.
2,609,833 (Orla E. Watson)—Fluid pressure range control.
2,610,107 (George M. Dreher)—Combustion analyzer.
2,610,300 (United States of America as represented by the Atomic Energy Commission)—Vapor flow control for a mass spectrometer.
2,610,471 (Union Carbide & Carbon Chemical Co.)—Apparatus and process for metering liquefied gas.
2,611,044 (Karl O. Siemon)—Electrical bin level controller.
2,611,218 (Spence Engrg. Co.)—Pilot-operated valve.
2,611,268 (National Research Corp.)—Velocity meter for gas flow.
2,611,271 (Jerguson Gage & Valve Co.)—Liquid level gage.
2,611,542 (Minneapolis-Honeywell Regulator Co.)—Fluid flow control device.
2,611,791 (Bendix Aviation Corp.)—Thermocouple.
2,612,607 (W. E. Stephens)—Mass spectrometer.
2,612,605 (Phillips Petroleum Co.)—Photometric analyzer.

Gaskets & Seals

2,610,075 (Crane Packing Co.)—Rotary mechanical seal with telescoping parts.
2,610,571 (General Electric Co.)—Rotating shaft seal.
2,610,872 (Dynamatic Corp.)—Shaft seal.
2,610,875 (General Electric Co.)—Shaft seal.
2,610,874 (Crane Packing Co.)—Driving means for fluid seals.
2,612,390 (Viscoseal Corp.)—Rotating shaft sealing unit.

Tanks & Vessels

2,609,305 (M. W. Kellogg Co.)—Laminated pressure vessels and method of manufacturing same.
2,611,504 (Chicago Bridge & Iron Co.)—Hanger for floating roofs.
2,611,511 (Chicago Bridge & Iron Co.)—Device for preventing evaporation loss from storage tanks.

Furnaces & Boilers

2,609,814 (Foster Wheeler Corp.)—Vertical cylindrical furnace with spiral coiled tube for heating fluids.
2,610,842 (Shell Development Co.)—Apparatus for even controlled and continuous indirect heating of fluids.
2,612,364 (Food Machinery & Chemical Corp.)—Regenerative furnace of the pebble bed type.

Heat Exchangers

2,609,888 (Aqua-Therm, Inc.)—Liquid-gas contact device.
2,611,584 (The Trane Co.)—Heat exchanger.
2,611,585 & 587 (Heat X-Changer Co.)—Heat exchangers.
2,611,586 (Joy Mfg. Co.)—Heat exchanger.
2,612,350 (Griscom-Russell Co.)—Expansion compensated, counter-current heat exchanger.

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(To obtain more data on advertised products see page 1680)

Named Fluor Technical Advisor

William R. Hainsworth has been appointed technical advisor to J. Robert Fluor, executive vice president of the Fluor Corp., Los Angeles, Calif.

Mr. Hainsworth

Mr. Hainsworth was formerly research director and vice president in charge of engineering for Servel Inc.

A chemical engineering graduate of the University of Washington, Mr. Hainsworth holds a M. S. degree from the California Institute of Technology, and a Ph. D. from the Massachusetts Institute of Technology. In 1933 he received the Munroe Award from the American Gas Association for the most outstanding contribution to the gas industry on an air cooled gas refrigerator.

Researchers Join Consolidated

Two important additions to the engineering and research staffs of Consolidated Engineering Corp. are Dr. Wilson S. Brubaker as senior research physicist and Dr. Paul Brock as engineering mathematician.

Dr. Brubaker, a graduate of Miami University (Ohio), will work mainly in the field of mass spectroscopy dealing with rapid, accurate analyses of unknown, complex mixtures of gases and liquids in the petroleum industry, chemical companies, atomic energy work, and in other civilian and military fields. Before joining Consolidated, he served for nine years as section manager, physics department, Westinghouse Electric Corp., in East Pittsburgh.

Dr. Brock, who received both his M.S. and Ph.D. from New York University, has been assigned to work with the company's computer group. He did computation work with the Kellex Corp. where he formerly served as head of the mathematics group, and for two years was in charge of an investigation of digital equipment in the United States.

Promotions At Hollingshead

In line with the R. M. Hollingshead Corp.'s current expansion and reorganization of its executive staff, A. E. Moore, V. M. Mantz and Dr. V. Esposito have been appointed to new positions in the firm's research and development division.

Mr. Moore, veteran of 29 years service with the company, has been appointed vice president and director of research and development. He is to be in charge of all matters pertaining to the operation and direction of Hollingshead's laboratories. Prior to his present appointment, he was director of the new products development division. He is a graduate of Drexel Institute of Technology.

Mr. Mantz has been appointed director of government and industrial research. He joined Hollingshead in 1931 as superintendent of lubricant production. In 1941, he was named assistant director of research, and in 1947 became director of research. A specialist in automotive products, Mr. Mantz also is a graduate of Drexel Institute.

Dr. V. Esposito, formerly assistant director, now becomes director of new products development, succeeding Mr. Moore. Dr. Esposito joined the company in 1944 as a chemist in the research division. He attended Philadelphia College of Pharmacy and Science and was graduated from Eckels College. He received his doctor's degree from the University of Pennsylvania in 1947.

Kellogg Advances Multhaup

Robert H. Multhaup has been appointed manager of the product engineering department of the M. W. Kellogg Co., designers and builders of petroleum and chemical processing plants. In this capacity, Mr. Multhaup will be in charge of the design and engineering of all fabricated products.

Mr. Multhaup

Mr. Multhaup joined the company last year as project engineer on rocket design work. For eight years previous to that, he was engaged in development work for the Elliott Co. where, as manager of the laboratory, he pioneered in the design of gas turbines for marine and locomotive use. He received his engineering degree from the University of Iowa, and is a member of the American Society of Mechanical Engineers.

Sale of Kodak Division Near

Negotiations for the sale of the equipment manufacturing portion of Eastman Kodak Co.'s Distillation Products Industries division to the Consolidated Engineering Corp. are underway and transfer of the business is expected about January 1, 1953. DPI's distillation operations and its business in vitamin concentrates and synthetic chemicals are not involved in the sale.

Consolidated Engineering expects that the purchase will increase the company's annual sales by more than $4 million, and will give them a leading position in the vacuum equipment field. They will lease and operate the vacuum equipment department's plant at its present location in Rochester, N. Y., until its own plant can be built.

Westenberg Joins M.D.I. Staff

J. Eugene Westenberg has joined the staff of Mechanical Design, Inc. as chief engineer. Aside from his duties with Mechanical Design, plans are for Mr. Westenberg to assist the sales department of Refinery Engineering Co.

A graduate of Armour Institute of Technology in Chicago, Mr. Westenberg has spent his entire career in the petroleum refining and petrochemical fields. Nine years with Universal Oil Products Co., Chicago, in research, process, design, and sales established his prominence in refining circles. During World War II he worked with the Petroleum Administration for War. After his stint with PAW he joined the Bechtel Corp., Calif., as chief process engineer on the Campbell Project at White Horse, Canada, for a period of eight months.

After leaving Bechtel Corp., Mr. Westenberg was with Republic Oil Refining Co. for three years in charge of their 100 octane aviation gasoline program. In his capacity with Republic, Mr. Westenberg supervised the engineering, design, construction and operation of the company's 100 octane plants.

He has devoted his efforts mostly to project management and sales spending one year with UOP in sales, three years with Jones & Laughlin as project engineer and most recently, two years with the Bechtel Corp. in New York and San Francisco doing both sales and project management. His work with Bechtel has been concerned with petroleum refining and petrochemical processing.

Norton Promotes Three

George H. Powers has been appointed refractories engineer with the Norton Co. of Worcester, Mass. He replaces Fred E. Leiby who retired last month after 29 years service with the company. Mr. Powers will be responsible for the New York and New Jersey territories with headquarters in the company's New York City office. Prior to the appointment, Mr. Powers was employed as a sales engineer in the refractories division of the Worcester sales office.

Mr. Powers

In other Norton promotions: Lincoln M. Johnson was named honing engineer to cooperate with the Micromatic Hone Corp. of Detroit, Mich. He will make his headquarters at the

company's Detroit office; and, Enfried T. Larson, formerly a sales engineer, has been appointed editor of technical publications.

Kidde's Atom Lab Readied

Under construction since late spring, the research and development laboratory of the Walter Kidde Nuclear Laboratories, located at 975 Stewart Ave., Long Island, was to be ready for occupancy about the first of November. Research operations were scheduled to start on November 1, although installation of certain specialized equipment needed to carry on nuclear research and development projects is scheduled to continue for several months.

The Kidde organization is the first privately-financed research organization devoted primarily to the development of atomic power for commercial and industrial purposes. The new laboratory facilities will serve also as headquarters for the firm's operations. A brick structure of modern design, the new laboratory comprises areas devoted to chemistry, physics, metallurgy, radiochemistry and materials testing.

Hooker Makes Additions

Hooker Electrochemical Co. has recently employed the following people:

Donald J. Stone joins the company as a mechanical engineer. He is a graduate of Purdue University and had been previously employed as a test engineer at Bell Aircraft and as an instrumentation engineer by Union Carbide and Carbon Corp.

Robert H. Pugh, a graduate chemist from Ohio Northern University, has been employed as a chemist in the works laboratory. He has had previous experience in the chemical field with National Carbon Co., the du Pont Co., United States Rubber Reserve and Harshaw Chemical Co.

Edward A. Hutton, a graduate of Clarkson College of Technology, has been added to the process study group as a chemical engineer.

Filtrol Sets Completion Date

Filtrol Corp. expects its $5 million ammonium sulfate and high purity alumina plant, near its present Vernon, Calif. (greater Los Angeles) plant, to be completed in the fourth quarter of 1953. J. H. Pomeroy Co., Inc., San Francisco, received the construction contract.

Alumina will be used for straight alumina catalyst, stabilized alumina catalyst and impregnated alumina catalyst. The ammonium sulfate will be marketed by Shell, stated Filtrol. Raw material will be acidic liquor.

Porter Buys Watson-Stillman

In a move to further diversify its manufacturing operations, H. K. Porter Co. Inc., Pittsburgh, has acquired the Watson-Stillman Co., Roselle, N. J., manufacturers of forged steel fittings and hydraulic equipment.

The Watson-Stillman Co. manufactures a complete line of forged steel fittings, hydraulic presses, jacks, pumps, shears, pipe benders and other hydraulic equipment for industry. Operations at Watson-Stillman will continue under the direction of its president, Edwin A. Stillman, and the fittings division will be operated as a division of H. K. Porter Co. Inc.

Barksdale Promotes Nelson

Barksdale Valves, newly incorporated, has promoted M. C. Nelson from general manager to vice president and director of the organization. In his new position, Mr. Nelson will direct the expanding sales activities of the corporation, now represented in 40 major industrial areas.

Joins Delanium Sales Staff

Robert F. Hainge has joined the sales staff of Delanium Carbon Corp. at the New York headquarters. He will handle the sale of graphite cubic heat exchangers, Paragrid absorption towers and other carbon products.

Mr. Hainge was previously associated with Graham Manufacturing Co. Inc., New York City, in heat exchanger and air ejector sales for 12 years.

Catalyst Plant On Stream

Houdry Process Corp's Paulsboro, N. J. plant has begun production of the new Type 3 catalyst. The catalyst is used in Houdriforming operations for up-grading naphtha to high octane gasolines, and for the production of aromatics. Initially, the Paulsboro plant is to produce the new catalyst for Houdriforming plants now under construction having a total capacity of approximately 25,000 b/d. In addition, the new plant has been designed to fill future industry requirements for the catalyst.

Glespen Returns To Cyanamid

G. L. Glespen, who held the post of chief of chemicals, containers and packaging branch of the Petroleum Administration for Defense, Materials Division, during a 10 months' leave of absence from American Cyanamid Co., has returned to the firm's New York office as assistant manager of the petroleum chemicals department. Before leaving for his PAD assignment, Mr. Glespen was technical supervisor in the same department.

B-L Transfers Brungraber

Bigelow-Liptak Corp., Detroit, Mich., has transferred L. E. Brungraber from the engineering department to its sales staff in New York

No FIRE Risks

Burling TEMPERATURE Controls

Pneumatic Model BA

When you control your refining process with Burling Pneumatic Temperature Controls you get amazing extra protection.

As steady unwavering heat is a prime necessity in refining petroleum, you will welcome the complete regulation a Burling Control gives, used either as a primary control or as a high temperature safety cut-out on existing control equipment.

The heat-sensitive tube is made of stainless steel or some other corrosion resisting alloy, thus eliminating the necessity of separate wells. Any standard pneumatic control pressure up to 30 psi can be used for operating a diaphragm type valve or motor. It is suitable for temperatures from sub-zero to 1800° F.

Write for prices, catalog and name of representative

Burling Instrument Company
4 Vose Avenue South Orange, N. J.
Temperature Controls since 1918

One of many reasons why skilled refinery workmen prefer
AIRETOOL TUBE CLEANERS

slip-fit construction

Each part of an AIRETOOL tube cleaner motor is made of heat treated alloy steel, precision ground to a perfect slip-fit. The operator can take the motor apart when necessary and quickly reassemble it right on the job without special tools. This convenience reduces down-time, makes maintenance easy. It is one of many basic, work-saving reasons why maintenance men specify AIRETOOL for fast, efficient cleaning of all types of refinery tubes, straight or curved. For full details write The AIRETOOL Mfg. Co., 836 S. Center St., Springfield, Ohio.

AIRETOOL furnace tube cleaner. Furnished with or without ball-bearing thrusts.

SLIP-FIT CONSTRUCTED MOTORS — 5-blade, 2-stage construction, each stage with double exhaust. Five lubrication points.

There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES: Philadelphia • New York • Chicago • Tulsa • Baton Rouge • Houston
REPRESENTATIVES in principal cities in U.S.A., Canada, Mexico, South America, England

Suppliers

City. He will work out of the New York office at 50 Church St. A graduate of Iowa State's engineering school, Mr. Brungraber will bring to his new assignment several years' experience spent in designing and estimating all kinds of industrial furnace enclosures.

Personnel Changes

Ashland Oil and Refining Co.—Erskine A. Owens appointed district manager of crude oil supply at the new Tulsa district office located in the Junior League Bldg., 114 East 5th St.

Calumet & Hecla Consolidated Copper Co.—E. W. Ervasti became manager of industrial sales in the Detroit Sales office of the Wolverine Tube division on October 1st. He was formerly the division's sales representative in the St. Louis area.

Manzel Co.—Ralph Nelson now represents the company in the West Texas and New Mexico area.

Expansion, Transition

Jefferies Engineering Co. of Westfield, N. J., has changed its name to Engineering Corp. of America. The firm specializes in the designing and building of mechanical and process equipment for the chemical and petrochemical process industries.

Graver Tank & Manufacturing Co. has opened a Pittsburgh district sales office with Robert E. Dunham as resident sales engineer at 401-B Grant Bldg., 330 Grant St., Pittsburgh 19, Pa.

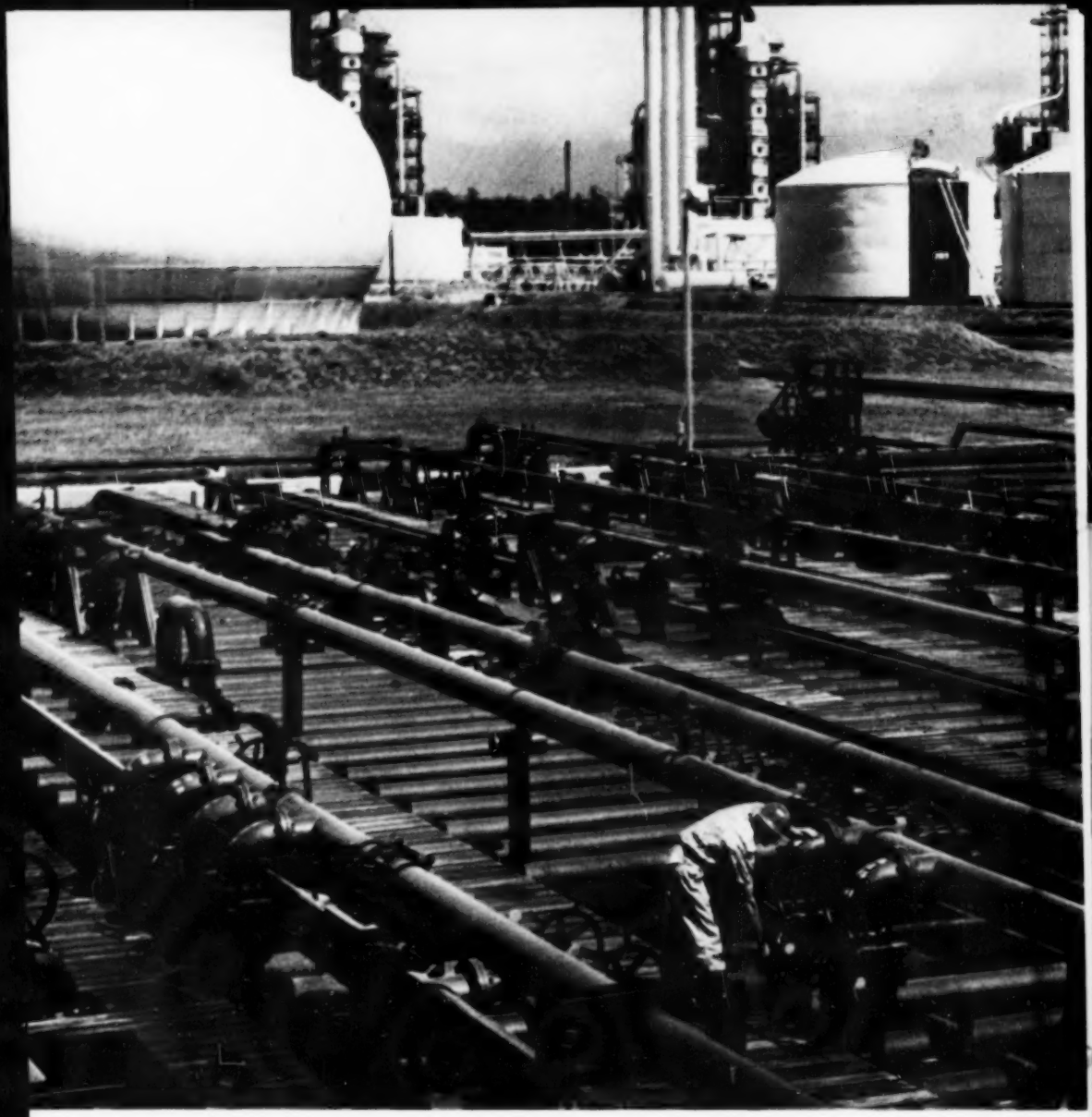
Hammel-Dahl Co. has moved to its new factory in Warwick, R. I., near Providence. For prompt delivery, all mail and parcel post should be addressed to the company, 175 Post Road, (Warwick), Providence 5, R. I. For shipments by truck and freight, the following address should be used: 175 Post Road, Warwick, R. I.

Claude S. Gordon Co. of Chicago has opened a new manufacturing plant on a 6½-acre site at Richmond, Ill. Modern new machinery has been installed for the manufacture of their line of thermocouples, pyrometer accessories, specialty instruments, and metallurgical testing machines.

Universal Oil Products Co.'s administrative and engineering offices are now located in their new building at 30 East Algonquin Road, Des Plaines, Ill.

Swartwout Co. has established a district sales office to service power plant equipment and Autronic control division accounts in the New England area. The office, which is located at 143 Broadway, Cambridge, Mass., will be under the direction of Robert E. Alexander, district manager.

(To obtain more data on advertised products see page 1680)



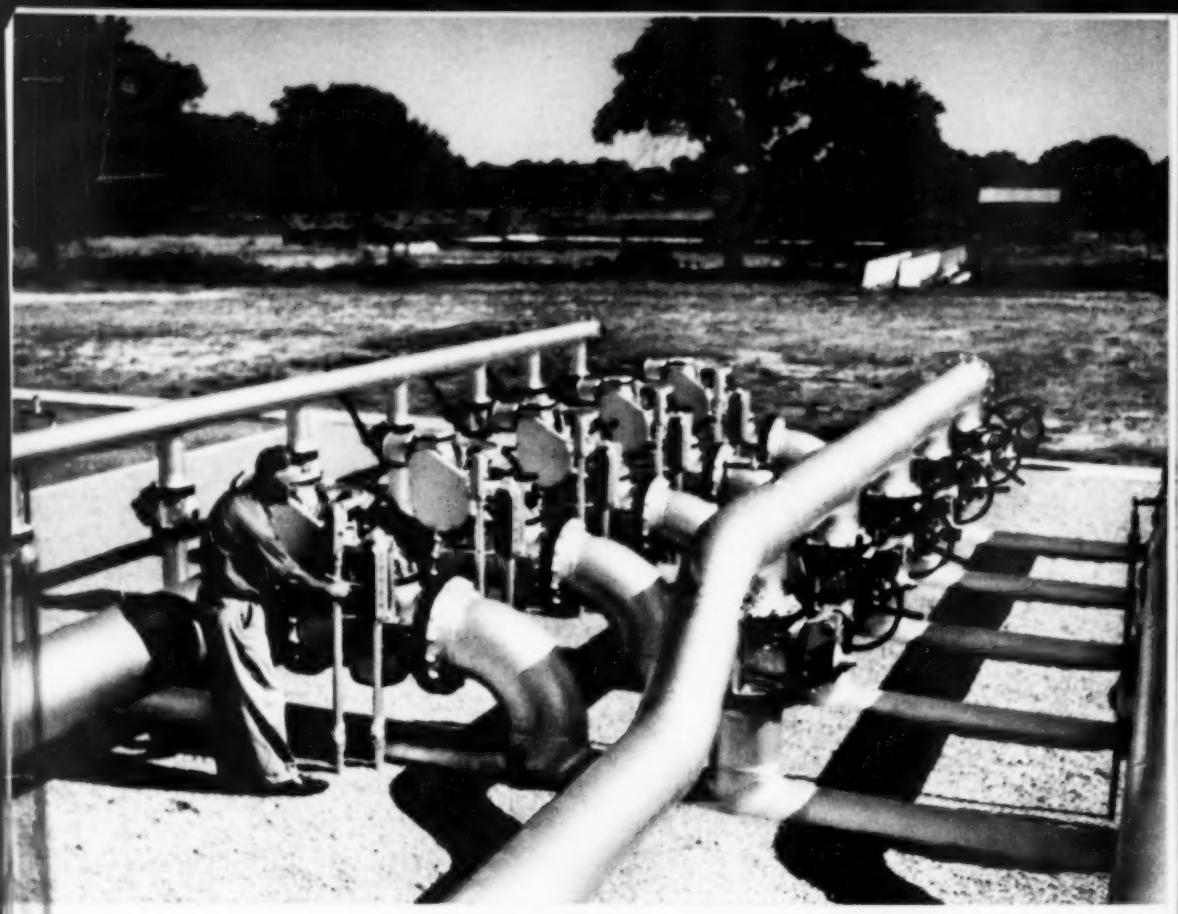
Manifold Control–THE SAFE, SURE NORDSTROM WAY

Often, in a single manifold, Nordstrom valves will be used to control several forms of gas, a variety of petroleum derivatives, or a diversified group of hard-to-hold chemicals.

Because of their versatility . . . because they are available in so many different metals, sizes, pressure classes and styles . . . because they are doubled-sealed with lubricants especially compounded for specific services . . . because they open and close on a quarter-turn—these are among the reasons Nordstroms are ideal for manifold service.

In your control manifolds—consider the advantages of specifying Nordstrom lubricant-sealed valves throughout.

Rockwell Built
Another Rockwell Product **Nordstrom** Valves



How To Save Money On Valves

These installations are illustrations of the best way to save money on valves: specify Nordstroms in the first place. In original cost, Nordstrom valves often cost no more; over the life of the line or the equipment they serve, they almost always cost much less.

Nordstroms, the original lubricated plug valves, have proved their economy through 30 years of hard service in several thousands of different types of processes in gas, petroleum, chemical and other technological industries. That experience, that performance, is your reference. Nordstrom Valves are built by the Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

Rockwell | **Built**
Another Product
Nordstrom Valves

API Awards Certificates of Appreciation To:

Albert E. Miller
Sinclair Refining Co.

W. J. Sweeney
Standard Oil Development Co.

K. C. Heald
Gulf Oil Corp.

C. V. Millikan
Amerada Petroleum Corp.

Four men who have contributed very materially to the API program of fundamental research in petroleum were awarded Certificates of Appreciation in recognition of their work, the group session on research at the 32nd annual meeting of the Institute.

Albert E. Miller, assistant to the vice president, Research and Development Dept., Sinclair Refining Co., New York, was cited for his constant effort during the past 20 years to improve the effectiveness of petroleum research.

Mr. Miller since 1946 has been secretary of the API Committee on Fundamental Research on Composition and Properties of Petroleum and he is chairman of the API Refining Division Committee on Petroleum Products. He was secretary of the Technical Advisory Committee of PAW during World War II and is chairman of the Technical Oil Mission's Study Group in the U.S.

A native Pennsylvanian, he graduated with a B.S. in chemistry at Pennsylvania State College in 1912. He went with Gulf Refining at Port Arthur as a chemist and assisted in process development. He later became assistant superintendent of the paraffin wax plant. He was employed by Sinclair Refining in Chicago in 1918, was there until 1921, spent three years in Europe and was assigned to the New York office on his return.

Dr. W. J. Sweeney, vice president of Standard Oil Development Co. in charge of research and development, New York, was cited for his ability to plan and execute research projects and his leadership in the scientific progress of the petroleum industry.

Dr. Sweeney was chairman of the API Advisory Committee on Fundamental Research and Composition of Petroleum from 1946-49 and has has been active on various of the individual project committees. A native of Massachusetts, he received a doctor's degree in chemical engineering from MIT and for 7 years was an assistant professor of chemistry at Pennsylvania State College.

He was director of the research and development department of the former Standard Oil Co. of Louisiana from 1934-36 and associate director of the Esso laboratories, Research Division, Standard Oil Development Co., from 1936-45. He became assistant manager of the Research and Development Department of SOD and is currently vice president of SOD in charge of research and development.

Dr. K. C. Heald, vice president of Gulf Oil Corp. in charge of production and pipe lines, was cited for his 23 years of meritorious service in having aided materially in the guidance of the fundamental research program on occurrence and recovery of petroleum. From 1926 to 1931 he was a member of the old Central Petroleum Committee which advised API directors on setting up original research projects. He was a member of the main API Advisory Committee on Fundamental Research on Occurrence and Recovery of Petroleum from 1931-39.

C. V. Millikan, chief petroleum engineer of the Amerada Petroleum Corp.'s Mid-Continent Division, received his award for 21 years of meritorious service in which he has rendered technical advice and administrative leadership to research project advisory committees and to project directors of the main API Advisory Committee on Fundamental Research on Occurrence and Recovery of Petroleum. A graduate of Oklahoma A. & M. College and the University of Pittsburgh, Mr. Millikan is a past chairman of the AIME Petroleum Division, and in 1944 received the Lucas medal.

Mr. Henderson

Mr. Prussing

Mr. Wilson

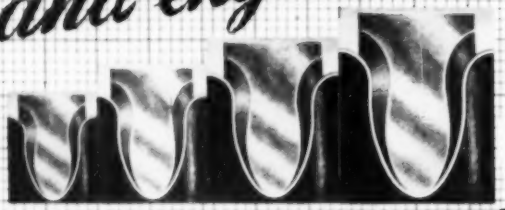
Mr. Moeller

Four members of the American Petroleum Institute Accident and Fire Protection Committees received Certificates of Appreciation on November 11 at the Institute's 32nd annual meeting at the Conrad Hilton Hotel in Chicago.

R. T. Henderson, Standard Oil Co. (Ohio), retired for 16 years of outstanding services rendered to API accident-prevention and fire protection committees. Retired since July 1, 1952, Mr. Henderson will perform as chairman of the Planning Committee of the Central Committee on Fire Protection as his last official committee service after the API meeting.

George F. Prussing, a consulting

Designed and engineered for proper depth of corrugation



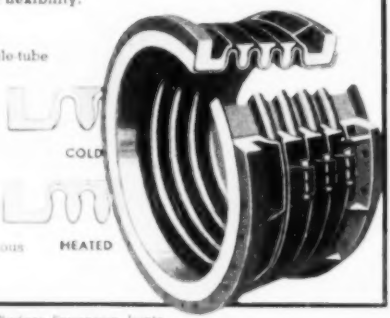
Badger Expansion Joints

Experience has proven that longer expansion joint life can only be safely assured by varying the depth of corrugation with relation to size and traverse per corrugation. In the regular practice of precision manufacture and engineering Badger Manufacturing Company has established standards for different diameters. *Not just a shallow and a deep corrugation, but precisely the accurate depth of corrugation needed.* Just one of the many important characteristics and reasons you should specify Badger Expansion Joints.

D-F S-E Directed-Flexing Self-Equalizing: an exclusive feature of Badger Expansion Joints. The flexing of the corrugations is progressively directed over each segment of each of the all-curve corrugations by correspondingly shaped self-equalizing rings. Localized stresses are eliminated insuring a more flexible longer lasting joint.

Buy Badger Joints and you get flexibility, D-F S-E and these features:

- Packless . . . pressure-tight single-tube requires no maintenance
- Compact . . . approximately the size of flanged fitting
- Special forming . . . no structure-weakening stresses
- Controlled heat treating . . . assures long life
- Wide range of traverse — pressure — temperature. Fabricated from deoxidized copper, stainless steel and special alloys to meet various operating conditions.



Original and Sole Manufacturer of Badger Expansion Joints

BADGER MANUFACTURING COMPANY

230 BENT STREET • CAMBRIDGE • MASS.

engineer in Washington, D. C., for 25 years of outstanding service as chairman of accident-prevention and fire-protection committees, and especially for valuable contributions in the preparation of national fire codes and API manuals. He has also aided the petroleum industry in protection against unnecessarily restrictive fire-protection laws and regulations.

H. J. Wilson, Tide Water Associated Oil Co., for 13 years of service as chairman and member of fire-protection committees, and especially for significant contributions in the preparation of the API manual, *Fire Protection in Refineries.*

B. A. Moeller, General Petroleum Corp., for 22 years service as a member of fire-protection committees, and especially for notable contributions in preparation of API fire-protection manuals.

* * *

On the heels of the announcement in PETROLEUM PROCESSING last month, (see What's Happening, Oct. '52 p. 1367) that W. R. Grace Co. would build their first petrochemical plant near Memphis, Tenn., came news of the formation of Grace Chemical Co. (see this month's What's Happening, p. 1543). Aside from the fact that the ammonia-urea plant and surroundings will cover a 277-acre area, perhaps the most important news lies in the fact that the leadership of the company has been placed in the hands of five of the most experienced and capable men on the American industrial scene.

Mr. Haslam

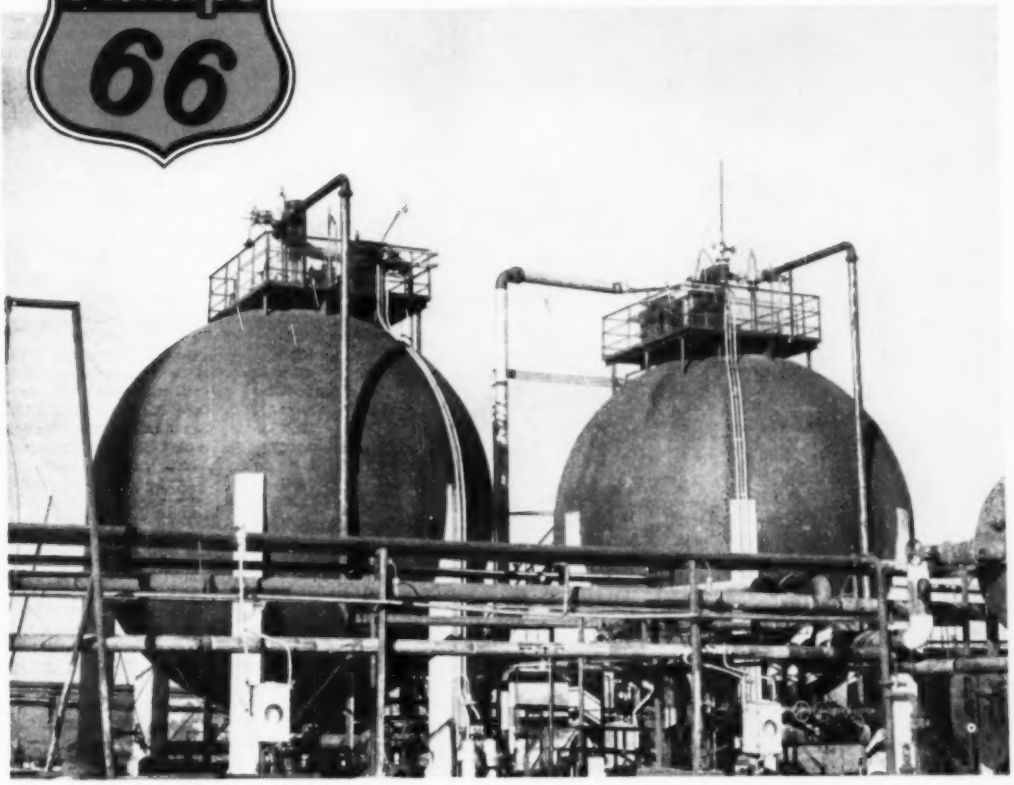
Mr. Dewey

Mr. Carriere

They are: **Charles E. Wilson,** former president of the General Electric Co.; **Robert T. Haslam,** a former vice president and director of Standard Oil Co. (N. J.); **Bradley Dewey,** president of the Dewey and Almy Chemical Co.; and **Edwin R. Gilliland,** dean of chemical engineering of the Massachusetts Institute of Technology; all named di-

Phillips 66

another leading refiner who desalts with PETRECO



Phillips Petroleum Company has earned a place of leadership in the oil industry by manufacturing and marketing products of the highest quality. To consistently produce excellent products, a refining organization must possess and utilize a high degree of technological know-how.

One phase of Phillips know-how is their insistence on the absolute minimum of residual salt in the crude charge. Like other leading refiners, Phillips knows that salt in the crude charge, even in nominal tolerances, is a certain trouble-maker. The fact that Phillips utilizes Petreco Electrospheres at Phillips, Texas, to hold the salt content of the crude charge to this refinery to their required low minimum is of considerable significance.

Like other leading refiners everywhere, Phillips not only produces the best products possible—they help to assure this excellence of product by utilizing Petreco Desalting, the desalting process with an established reputation and known standards of performance and service.

Complete information on Petreco Electric Desalting and other refinery processes is yours for the asking.

PETROLITE CORPORATION
PETRECO DIVISION

3202 S. WAYSIDE DRIVE, HOUSTON 3, TEXAS
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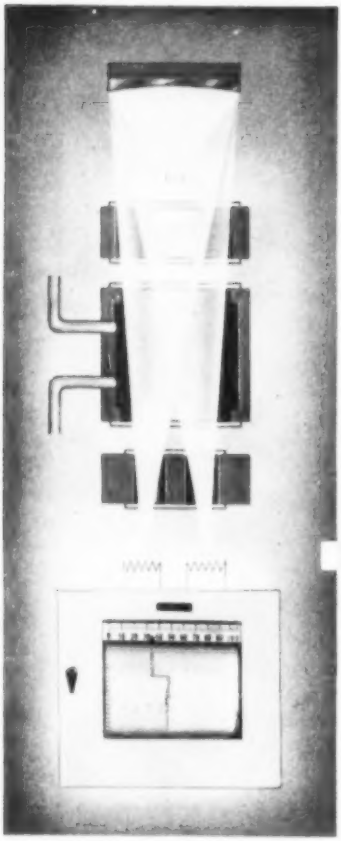
PETRECO

ELECTRIC PROCESSES FOR THE PURIFICATION OF PETROLEUM

CRUDE OIL: **REMOVAL OF SALTS, SOLIDS AND OTHER IMPURITIES; DEHYDRATING**
DISTILLATES: **ACID, CAUSTIC AND DOCTOR TREATING**
FUEL STOCKS: **DESAPONIFICATION**

PR 52-4

FOR OUTPUT BEYOND RATED CAPACITY



Without AFTERBURN

The Baird Associates plant stream analyzer, used as an indicator of CO concentration in catalyst regenerator flue gas, can revolutionize your f.c.c. operation.

The start of afterburning is revealed so quickly that the afterburn can be quenched at once by the lean-phase water sprays.

This means that there is no loss of production, and no risk of damage to the regenerator.

This means that enormously increased conversion rates can be reached — without impairing catalyst life.

This means that the huge production demanded today can be safely met — by plants that use infrared analysis in controlling regenerator operation.

Based on measurement of differential infrared absorption, the Baird Associates plant stream analyzer is simple, accurate, sensitive, and rugged. It has proved itself reliable under actual plant conditions. WRITE US — WIRE US — OR TELEPHONE US — TODAY.

PROCESS CONTROLS

a division of Baird Associates, Inc.

11 UNIVERSITY ROAD CAMBRIDGE 38, MASSACHUSETTS

rectors. Appointed plant manager of the new ammonia-urea plant is **John Gerard Carriere,** formerly manager of the Engineering and Construction Division of the Hanford Works, (General Electric Co.) of the Atomic Energy Commission program. Previous to that he was with Shell Chemical Co. for 15 years, and the C. F. Brown & Co., engineers and constructors of oil refineries and chemical plants in Alhambra, Calif.

Mr. Wilson became associated with the Grace Co. in 1952. He left General Electric in 1950 after 51 years of service with them. He started as office boy, and left as president. He has worked in practically every phase of the electrical field.

Mr. Haslam joined the Grace organization in 1951. He had been with Standard Oil Co. (N. J.) since 1931, at which time he became vice president and general manager of its subsidiary, Standard Oil Development Co. In 1935 he was named general sales manager of Jersey Standard, a director in 1942, and vice president in 1946.

Mr. Dewey was named a director of the new petrochemical firm last month. He has headed the Dewey and Almy Chemical Co. since he founded the company in 1919. He has been awarded the Medal for Merit for work on the atomic bomb tests at Bikini Atoll, and is a member of the Advisory Board to the Research and Development Branch of the U. S. Army Quartermaster Corps, and Consultant to the Director of the Office of Scientific Research and development.

Professor Gilliland joined the faculty of M.I.T. in 1934, served as assistant rubber director in charge of research and development in the Office of the Rubber Director during 1942-44 and as a member of the National Defense Research Commission from 1944 to 1945.

Mr. Carriere is a graduate of Bliss Electrical School in Washington, D. C., and a mechanical engineering graduate of Stanford University, class of 1926. He is a member of the American Society of Mechanical Engineers.

° ° °

Thomas E. Stockdale has been named to manage Standard Oil Co.'s (Ind.) projected refinery at Mandan, N. D. He has been general superintendent of the Wood River, Ill., refinery for the past 10 years. A graduate of the University of Illinois, Mr. Stockdale has been with Indiana Standard since 1923.

Ford H. Blunck has succeeded Mr. Stockdale as general superintendent at Wood River. He was previously manager of the projects, capital expenditures, and miscellaneous contracts division in the general office manufacturing department. He is suc-

ceeded in this capacity by **P. C. Livesay**, who has been assistant general superintendent of the Whiting refinery since 1950.

* * *

Homer Reed, chief engineer of the Union Oil Co. of California, has been appointed president of Brea Chemicals, Inc., subsidiary being formed by Union Oil for development, manufacturing and marketing of petrochemicals. Mr. Reed is a graduate of California Institute of Technology.

Mr. Reed

G. H. Hemmen, superintendent of Union's refinery at Oleum, succeeds Mr. Reed as chief engineer. **H. C. Meiners**, assistant superintendent at Oleum, replaces Mr. Hemmen as superintendent.

* * *

H. W. Field has assumed the duties of **W. F. Stroud**, vice president and general manager of manufacturing for the Atlantic Refining Co. Mr. Stroud is on an extended sick leave of absence. Mr. Field is a vice president and director of the company, and is also manager of research and development. He joined the company in 1928, shortly after graduation from the University of Pennsylvania.

* * *

R. Chester Reed, president of The Texas Co., was reelected to serve a second three-year term as a member of the board for the Packaging Institute during the Institute's recent packaging forum in New York. Mr. Reed was also reelected vice president of the Institute. **Dr. L. V. Burton** was reappointed executive director of the Institute.

* * *

John P. Remensnyder has been elected to the newly-created position of chairman of the board of Heyden Chemical Corp. and **Simon Askin** has been elected president. Mr. Remensnyder is also chairman of the board and a director of St. Maurice Chemicals Ltd. of Varennes, Quebec. Mr. Askin has been vice president in charge of industrial relations and purchasing with Heyden since 1948. He has also served as a director of the company since that time.

* * *

B. Brewster Jennings, president of Socony-Vacuum Oil Co. Inc., received the Secretary of the Navy's Distinguished Public Service Award on October 21 for his "important role in the successful supply of petroleum for the Allied forces fighting on a worldwide front" during World War II. The award, highest the Navy may

From Ambès to Aruba...

More major oil fires have been put out with Pyrene Air Foam Equipment than with any other. Throughout the world—the Middle East, the Far East, Europe and South America—Pyrene® has long been *the* equipment for oil field and tank farm protection. Pyrene is available to you. Wherever *you* are—whatever *your* hazard—Pyrene is prepared to provide you with a built-in air foam system you can count on. For complete information, or the help of a Pyrene engineer, write us today.

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Affiliated with C-O-Two Fire Equipment Co.
The Pyrene Company, Limited, England
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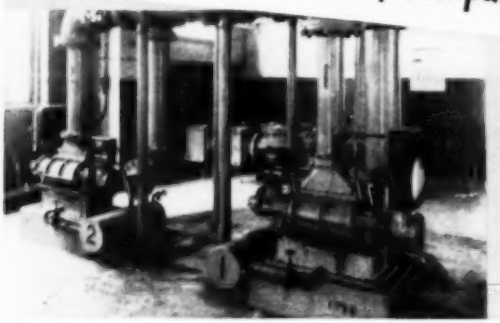
Engineering sales and service representatives: Stentz Equipment Co., P.O. Box 3367, Tulsa, also Dallas, Houston, Midland, Odessa • Horn Fire Equipment Co., 4917 Sheila, Los Angeles

(To obtain more data on advertised products see page 1680)

MEASURE THESE VALUES WHEN YOU BUY METERS

Accuracy·Capacity·Compactness



Part of an installation of nine R-C Positive Displacement Meters in large chemical plant. Capacities from 3,000 cfh to 130,000 cfh.

Industrial buyers rate R-C Positive Displacement Meters "tops" in these basic essentials.

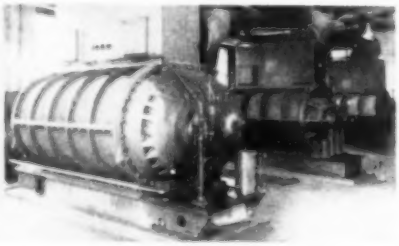
Accuracy—Not affected by pressure, wide variations in loads or other variables. Simple design, with no vanes, valves or small parts, results in maintained accuracy over long years of operation.

Capacity—from 1,000 cfh to 1,000,000 cfh in one unit, to meet practically any industrial metering requirements. Ample ability to absorb overloads.

Compactness—foot for foot of capacity, R-C Meters are the smallest made for industrial use. Can be "tucked away" in relatively small space without loss of valuable production area.

These values have long been proved by large and small industrial plants and public utilities. More R-C Meters are used by gas producing plants, for their own manufacturing and for commercial customers, than any other make. For details on sizes and construction, ask for Bulletin 10-B-14.

ROOTS-CONNERSVILLE BLOWER CORPORATION
524 Texas Avenue, Connersville, Indiana



Three large R-C Meters in public utility plant. Unit in foreground has capacity of 1,000,000 cfh.

ROOTS-CONNERSVILLE BLOWER
A DIVISION OF DRESSER INDUSTRIES, INC.
BLOWER BUILDERS SINCE 1854

confer on a civilian, was presented to Mr. Jennings during a special ceremony at the Pentagon by Secretary of Defense, **Robert A. Lovett.**

* * *

A. H. Eron has been appointed director of engineering with Sinclair Research Laboratories. Mr. Eron is a mechanical engineering graduate from the University of Wisconsin. His assignments with the company have included the design and construction of experimental petroleum processing plants. Until receiving his latest appointment, Mr. Eron had been assistant director of engineering at Harvey.

Dr. K. A. Smith has been promoted to director of the light oils division.

* * *

George W. Jandacek has joined the staff of Deep Rock Oil Corp.'s research and development department. He will serve as a chemical engineer at the Cushing, Okla., refinery. Mr. Jandacek is a graduate of Northwestern University.

* * *

Dr. Raymond H. Hartigan has been appointed assistant director of research on the executive staff of the Mellon Institute. He joined the Institute in 1941 as a fellow on a Koppers Co. Inc. research program. In his investigational work he contributed significantly to the development of the hydrogen cyanide-hydrogen sulfide recovery process now in operation at Koppers' Kearny, N. J. plant. In 1950 he was appointed manager of the laboratory section in Koppers research department and returned to the Institute in 1951.

* * *

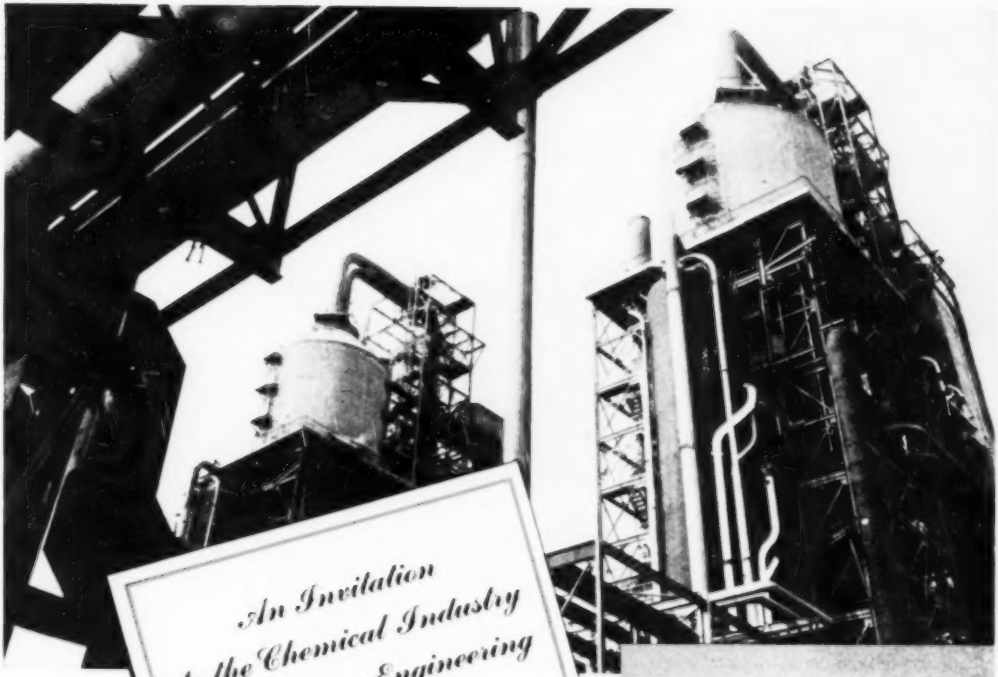
Dr. S. A. Ballard has been appointed department head of the petroleum refining department at Shell Development Co.'s Emeryville laboratories in California. He will assume the duties heretofore performed by **Dr. B. S. Greenfelder,** who will now devote his full attention to his principal duties as an associate director of research. Dr. Greenfelder will continue to direct the activities of the petroleum refining, organic synthesis and reaction kinetics departments.

JAMES P. O'DONNELL
Engineers

PETROCHEMICAL PLANTS

DESIGN—PURCHASING
INSTRUMENTATION
CONSTRUCTION SUPERVISION

39 Broadway New York 6



An Invitation to the Chemical Industry from Chiksan Engineering

CHIKSAN makes a range of ball bearing swivel joints with packing materials to handle practically all types of salts, acids, alcohols, glycols, aldehydes, alkaline solutions, animal oils, aromatics, chlorine derivatives, volatile gases and soaps.

Whether it's propane, butyl alcohol, vegetable oils or sulphuric acid, CHIKSAN loading racks with ball bearing swivel joints can be depended upon to handle these hard to handle chemical products with ease, economy and complete safety.

Chiksan has material and packing specification sheets listing 317 chemical products with recommendations for types of joints, metal and packing material to be used.

Write for Chiksan Application Data Sheet and Catalog 51-C Dept. No. 11-IEC

The Flow of Enterprise Relies on **CHIKSAN**

Ball-Bearing Swivel Joints

Representatives in Principal Cities

CHIKSAN COMPANY • **BREA, CALIFORNIA** • **Chicago 28, Illinois** • **Newark 2, New Jersey**

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.

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ACS Monograph on Styrene Dedicated to Willard H. Dow

Styrene. American Chemical Society Monograph Ser. 115. by R. H. Boundy and R. F. Boyer. 8½ x 9¼ in., xxiv + 1200 pages, illustrated, indexed, stiff cloth binding. Reinhold Publishing Corp., 330 West 42nd St., New York 36, N. Y. $20.00

Another valuable book to be added to the petrochemical man's library is this latest ACS Monograph which completely covers styrene. Some 1200 to 1300 pages contain its history; manufacturing methods; physical properties, chemistry, analysis and handling of the monomer; its polymers, copolymers and derivatives.

The section on polystyrene deals with physical behavior, derivatives and resins; German styrene practice, and concludes with a discussion on the fabrication of polystyrene, e.g., compression molding, extrusion, and shaping by cutting solid polystyrene into commercially useful articles.

Recent advances in the field are covered in the special appendix, which includes a comprehensive discussion on vinyltoluene, a monomer which is similar to styrene. Vinyltoluene utilizes ethylene and toluene as raw materials, and in most cases is a satisfactory substitute for styrene in the manufacture of synthetic rubber, polymers and latex coatings. It is pointed out that toluene is more easily made from petroleum and natural gas hydrocarbons than is benzene. Benzene is needed in styrene manufacture.

The book is dedicated to Willard H. Dow, who inspired the research work on styrene at the Dow Chemical Co. He offered all of his company's manufacturing experience to the government when the synthetic rubber program was proposed, and was responsible for the suggestion to write this monograph.

Authors of the monograph are R. H. Boundy and R. F. Boyer, both of the Dow Chemical Co. Mr. Boundy is manager of the plastics division, and Mr. Boyer is director of the physical research laboratory.

Texaco Man Compiles Data On Principal Fats

Properties of the Principal Fats, Fatty Oil, Waxes, Fatty Acids and Their Salts. by M. P. Doss. 8½ x 11 in. (horizontal), 214 pages, indexed. The Texas Co., 135 E. 42nd St., New York, N. Y. $3.00

Tabled chiefly for manufacturers of lubricants this book covers the properties of approximately fifty of the principal fats, fatty oils, and waxes. Over 800 aliphatic acids are tabulated. Data are given on salts of fatty acids ranging from aluminum through zirconium. Approximately 1,750 salts are listed.

The author is technical librarian of The Texas Co., Mr. M. P. Doss. He is also a past chairman of the program committee of the division of chemical literature of the American Chemical Society.

Improvements Noted On Maintenance Coverage

Techniques of Plant Maintenance. 1952. 8½ x 11-in., 181 pages, stiff cloth binding. Clapp & Poliak Inc., 341 Madison Ave., New York, N. Y. $6.00

Last year we reported in these columns that the 1951 edition of this book had improved upon its predecessors. (See PETROLEUM PROCESSING, September 1951, p. 1021). This year's edition has done it again. The improvement is noteworthy in presentation and organization of subject matter, and in the handling of the questions and answers session which follow each topic. Maintenance men should profit from the material covered by these papers and the sessions which followed each. Among the topics covered: "How To" maintain plant buildings, electrical equipment, chemical plants; preventive maintenance, project preparation and cost control.

Fundamental Data Given On Temperature Control

The Measurement and Control of Temperatures In Industry. by R. Royds. 5½ x 8½-in., viii + 260 pages, indexed, stiff cloth binding. Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y. $5.00

This book is quite fundamental in its presentation of the various methods and types of equipment used for temperature measurement. However, the fundamentals are covered very thoroughly, with no assumptions on the author's part of expecting the reader to be as far advanced as an expert in the field.

Coverage includes: standard scales of temperature, expansion thermometers, electrical thermometers and pyrometers, galvanometers, indicators, recorders and controllers of tempera-

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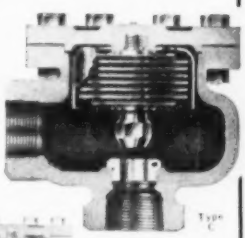

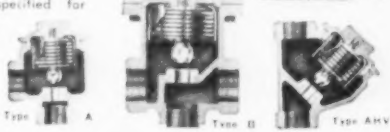

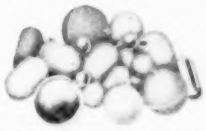

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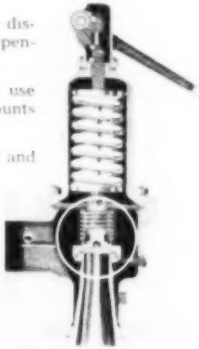

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ture, and various other pyrometers. The chapter on measurement of rapidly fluctuating temperatures covers methods used as far back as 1891, and progresses through to the latest methods employed. Considerable space is given to the standardization and automatic control of temperatures in industry, and the saving of fuel and labor by the application of automatic temperature controls. Numerous equations and graphs are given to aid in calculations.

Pipe Fabrication Institute Revises Piping Standards

End Preparation and Internal Machining for Machined Backing Rings for Butt Welds. Standards Bulletin, 8½ x 11-in., four pages. Pipe Fabrication Institute, 811 Clark Bldg., Pittsburgh 22, Pa. Available on request without cost.

This bulletin supersedes the first standards bulletin issued by the Institute almost four years ago. Standards have been revised to meet present day high pressure and temperature piping requirements. It includes design changes that are to minimize the amount of weld metal required and the resultant shrinkage stresses in the weld.

Books Received . . .

The Engine Indicator For Performance Evaluation, by J. D. Hines. Research Engineer. 5 x 7½ in., 33 pages, illustrated, heavy paper cover. The Cooper-Bessemer Corp., Dept. N-19, Mount Vernon, Ohio. $1.50.

Pressure-Volume-Temperature Relationships of Organic Compounds, Third Edition, by Robert R. Dreisbach. 8½ x 11-in. (horizontal), xi + 303 pages, stiff cloth binding, compounds classified according to their Cox chart families. Handbook Publishers Inc., Sandusky, Ohio. $10.00.

Association Publications

Service Classifications and Designations for Lubricating Oils for Automotive Type Engines, 4 x 9 in., 10 pages, paper cover. In lots of 1,000: $17. PDH Baltimore 3. 500: $25. PDH Baltimore 100: $6, postpaid. 11: $1, postpaid. Order through American Petroleum Institute Division of Marketing, 1623 K St., NW, Washington, or the American Petroleum Institute, 50 W. 50th St., New York 20, N. Y.

Government Publications

Analyses of Crude Shale Oil, Report of Investigations 4995, by R. F. Stevens, G. U. Thiessen, and John S. Ball. 8 x 10½ in., 11-20 pages, heavy paper cover.

Natural-Gasoline and Cycle Plants in the United States, Information Circular 7615, by D. S. Cobb and E. M. Seeley. 8 x 10½ in., 11 pages, heavy paper cover.

Petroleum and Natural-Gas Research Progress, Bureau of Mines, Fiscal Year 1951, Information Circular 7643, by E. A. Cutler and others. 8 x 10½ in., 10-11, 16 pages, illustrated, heavy paper cover. These bulletins can be obtained free from the Publications Distribution Section, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

Analyses of Canadian Crude Oils, by H. M. Tratman, F. H. Steers, and F. K. Goodspeed. 6½ x 9½ in., 90 pages, heavy paper cover. To be ordered as Mines No. 852, Department of Mines and Technical Surveys, King's Printer and Controller of Stationery, Ottawa, Quebec, Canada. Price 50 cents.

ASME's Annual Meeting To Cover Vital Plant Equipment Problems

PAPERS on "Petroleum-Refinery Heat Exchangers," by M. S. Northrup, Standard Oil Development Co., and "Approaching the Control Problem for the Automatic Chemical or Petroleum Plant," by M. V. Long and E. G. Holzmann, Shell Development Co., are among the many interesting topics on tap for refinery and petrochemical men at the annual meeting of the American Society of Mechanical Engineers. The meeting is scheduled from November 30-December 5 at the Hotels Statler and McAlpin in New York City. Mr. Northrup's paper will be delivered Tuesday, Dec. 2, at 2:30 P. M. at the panel discussion on heat exchangers, and Messrs. Long and Holzmann's will be delivered at the same time before an audience of top management, materials handling personnel, safety and junior technicians.

A session on Power is scheduled for 8:00 P. M., December 2, with discussions on "Quick Starting of Boilers," by W. H. Rowand, Babcock and Wilcox Co.; and two discussions on "Quick Starting of Steam Turbines," one by Carl Schabtach, General Electric Co., and another by C. D. Wilson, Allis-Chalmers Mfg. Co.

Under the auspices of the ASME and in conjunction with the annual meeting, the 20th National Exposition and Power Show will be displayed in Grand Central Palace from December 1-6. Power plant equipment and economy will be under review as well as technical advances of a revolutionary nature.

AIChE Papers Cover Processes, Economics

FIVE symposia, two panel discussions, three sessions devoted to general papers, and plant inspection trips comprise the program of the American Institute of Chemical Engineers' forty-fifth annual meeting in Cleveland for Dec. 7-10. Headquarters for the meeting will be at the Hotel Cleveland, and some events will be held at the Carter Hotel.

T. Weaver will discuss the "Economics of Acetylene by the Wulff Process" at the general technical session, scheduled to take place Monday Dec. 8 at 2:00 P. M. A high pressure symposium is to be held Tuesday morning, Dec. 9, and A. V. Slack, H. Y. Allgood, and H. E. Maune will deliver "Operating Problems in Ammonia Synthesis." E. R. Gilliland and R. J. Kallal will speak on "Telemeric Reactions of Ethylene and Alcohols" at this session.

A number of papers dealing with the chemical engineer's knowledge and use of patent laws, and engineering statistics will be presented during the four-day meeting. The three sessions on general papers will cover several aspects of unit operations, industrial processes, and waste disposal.

NGAA Papers To Stress Equipment Efficiency

THREE papers on equipment efficiency and maintenance, and one paper on infrared analysis are the outstanding features of the Nov. 21 regional meeting of the Natural Gasoline Association of America to be held at the Herring Hotel in Amarillo, Texas.

After the opening remarks of NGAA president, John F. Lynch, at 9:30 A. M., the morning program

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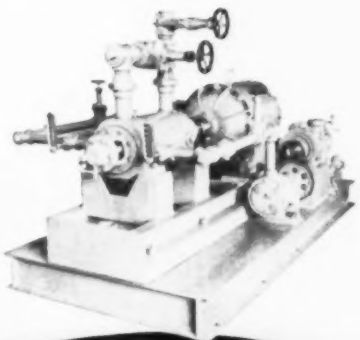

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will be under way with J. T. Russell, Panhandle Eastern Pipe Line Co., as presiding chairman. "Practical Applications of Infrared Analysis," will be delivered by Paul Buchanan, Panama Corp. J. S. Connors, Phillips Petroleum Co., is scheduled to give the "Benefits of Good Heat Exchanger Maintenance."

Howard E. Felt, Warren Petroleum Corp., will be chairman of the afternoon session which begins at 2:00 P. M. "Factors in the Efficient Operation of Boilers and Direct Fired Heaters," by O. S. Hubbard, Wickes Boiler Co., and "Factors Effecting Compressor Efficiency," by William Hardwick, Cooper-Bessemer Corp., will be presented at this session.

The "Cooling Tower" social begins at 5:30 P. M., through the courtesy of the Natural Gasoline Supply Men's Association.

Oil Man's Calendar

NOVEMBER

American Standards Assn., 34th annual meeting, Waldorf-Astoria Hotel, New York, N. Y. Nov. 19.

National Assn. of Corrosion Engineers, Western Region Second Annual Corrosion Conference, Biltmore Hotel, Los Angeles, Calif. Nov. 20-21.

Harbor Junior College, Second Annual Instrument Maintenance Short Course, Los Angeles, Calif. Nov. 20-22.

Natural Gasoline Assn. of America, regional meeting, Herring Hotel, Amarillo, Texas. Nov. 21.

American Institute of Electrical Engineers, technical conference for the subcommittee on electrically operated recording and controlling instruments, Benjamin Franklin Hotel, Philadelphia, Pa. Nov. 17-18.

American Society of Mechanical Engineers, annual meeting, Hotels Statler and McAlpin, New York City. Nov. 30-Dec. 5.

DECEMBER

20th National Exposition of Power and Mechanical Engineering, six conventions with the annual meeting of the American Society of Mechanical Engineers, Grand Central Palace, New York City. Dec. 1-6.

American Institute of Chemical Engineers, annual meeting, Hotels Cleveland-Cleveland-Statler, and Carter, Cleveland, O. Dec. 7-10.

Chemical Specialties Manufacturers Assn., 39th annual meeting, Hotel New Yorker, New York City. Dec. 8-9.

1953

JANUARY

Society of Automotive Engineers, annual meeting and engineering display, Sheraton-Cadillac Hotels, Detroit, Mich. Jan. 12-16.

Plant Maintenance Show, Clapp & Poliak Inc., Public Auditorium, Cleveland, O. Jan. 19-22.

American Institute of Electrical Engineers, Winter general meeting, Hotel Statler, New York City. Jan. 19-23.

American Society for Testing Materials, Committee D-19 on Industrial Water, St. Louis, Mo. Jan. 26-28.

MARCH

American Institute of Chemical Engineers, Buena Vista Hotel, Biloxi, Miss. Mar. 8-11.

National Assn. of Corrosion Engineers, North Central Conference and Exhibition, Hotel Sherman, Chicago, Ill. Mar. 16-20.

Western Petroleum Refiners Assn., annual meeting, Plaza Hotel, San Antonio, Texas. Mar. 23-25.

APRIL

American Institute of Chemical Engineers, joint meeting with the Chemical Institute of Canada, Royal York Hotel, Toronto, Canada. April 26-29.

Natural Gasoline Assn. of America, 32nd annual convention, Rice Hotel, Houston, Texas. Apr. 29-May 1.

MAY

American Petroleum Institute, Division of Refining, mid-year meeting, Hotel Commodore, New York City. May 11-14.

International Petroleum Exposition and Congress, Hall of Science, Tulsa, Okla. May 14-23.

High Rate of Crude Runs Threatens A Large Buildup in Gasoline Stocks

THE reduction in refinery gasoline stocks from the last of March to Oct. 18 has been nearly 37,000,000 bbls., whereas withdrawals in the same number of weeks in 1951 were around 29,240,000 bbls. (API revised figures for finished and unfinished stocks). In normal years, this might indicate that refiners had cut deeper into their inventories to meet demand during the heavy consumption period, in place of stepping up their production of gasoline.

However, because of the strike of refinery workers in May, the past few months have not seen a normal working of gasoline supply-demand relationship. Stocks were cut into by over 28,000,000 bbls. in May, to make up for the curtailment in output at the strike-bound plants. In May of 1951, the reduction was around only 6,000,000 bbls.

Refiners were able to meet practically normal demand for motor fuel in May, but in so doing they reduced their stocks to around 122,000,000 bbls. on May 31, as compared with inventories of over 139,000,000 bbls. on June 2, 1951.

To provide sufficient supplies to meet gasoline demand during the summer, and also to build up heating oil stocks to the required level this fall, refiners started in June to materially increase their runs to stills. How well they succeeded in both these objectives is shown by the fact that gasoline stocks were not further reduced over the summer and, on Oct. 18, were around 122,000,000 bbls. This is practically the same level as stocks on Oct. 20, 1951, which had been reduced from over 139,000,000 bbls. on June 2nd. Table 1 shows the changes in refinery gasoline stocks, in this period, for the past two years.

In the period since May 31st, heating oil stocks (kerosine and distillate fuels) have been built up to the highest point on record, nearly 156,000,000 bbls. on Oct. 18, which is now considered in most quarters adequate to start this heating season.

Coming into the normal season of reduced motor fuel consumption, refiners would seem to have two alternatives to avoid unduly building up their gasoline inventories: (1) cut crude runs to stills and (2) switch yields to make more heating oils, or to do both, increasing distillate yields within the limits of flexibility.

Indicated crude runs to stills in October were at a rate just under 7,000,000 b/d avg. The Bureau of Mines forecasts runs in November of 6,910,000 b/d avg.

The Independent Petroleum Assn. of America, in its quarter-by-quarter forecast of supply and demand, estimates crude runs for the fourth quarter at 6,956,000 b/d avg., and for the first quarter of 1953 at 6,850,000 b/d avg. The IPAA places gasoline demand, including exports, at 3,210,000 b/d avg. for the last quarter of 1952, and an average of 3,010,000 b/d for the period Oct. 1-March 31, 1953. This latter figure is 3.6% greater than the same period the year preceding.

Refinery gasoline stocks of 133,000,000 bbls. are predicted by this same agency for the end of 1952, about the same figure as actual stocks at the end of 1951. Stocks of around 160,000,000 bbls. are predicted for March 31, 1953; actual stocks on March 31, 1951 were approximately 150,700,000 bbls.

Referring to Table 1, gasoline stocks on the East Coast on Oct. 18 were 31,207,000 bbls. as compared with 29,128,000 bbls. on Oct. 20, 1951. Combined stocks on the East and Gulf Coasts were 55,394,000 bbls., compared with 53,461,000 bbls. on Oct. 20, 1951. Stocks in the Okla.-Kans.-Mo. district, 11,675,000 bbls., are about 500,000 bbls. less than a year ago.

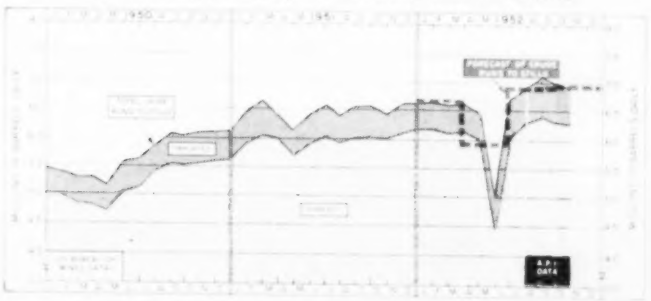
Primary heating oil stocks in the U. S. on Oct. 18th, 155,711,000 bbls., were over 7% larger than the 144,360,000 bbls. on Oct. 20, 1951. Stocks east of California, 142,961,000 bbls., were 7% larger than the 134,045,000 bbls. in storage Oct. 20, 1951. Stocks on the combined East and Gulf Coasts were 85,779,000 bbls., compared with 80,192,000 bbls. the year before. The largest change was in the Okla.-Kans.-Mo. district, where stocks on Oct. 18, 16,042,000 bbls., were 16% larger than the 13,779,000 bbls. on Oct. 20, 1951.

Secondary stocks of heating oils now being reported regularly through the Bureau of Census, showed a total of over 29,000,000 bbls. on Sept. 1st, nearly 2,000,000 bbls. higher than the comparable figure in 1951. Most of the increased inventories were in District 1, the eastern seaboard.

Table 1—Changes in Refinery Gasoline Stocks by Districts Summer of 1951 and 1952, 1000 Bbls.

	1951		1952	
	Oct. 20	June 2	Oct. 18	May 31
East Coast	29,128*	31,662	31,207	28,225
Gulf Coast	24,333	26,770	24,187	23,233
Total Coasts	53,461	58,432	55,394	51,462
Appalachian	5,891	5,674	5,367	4,946
Ind., Ill., Ky.	24,666	26,825	25,092	25,583
Okla., Kans., Mo.	12,158	14,610	11,675	12,067
Other Inland	10,443	12,454	10,197	11,798
Total East of Cal.	106,619	122,025	107,725	106,376
California	20,824	17,633	14,227	15,518
Total U. S.	121,430	139,658	122,092	121,894

Fig. 1—Slight Drop in Crude Run to Stills



Crude Runs to Stills

Daily Average (1000 bbls.)

		Domestic	Foreign	TOTAL
1951	API*	6,260	661	6,921
1951	BM	6,060	441	6,440
Change		200	220	420
% Change		3.3	49.9	6.5

*Through Oct. 25

Total (1000 bbls.)

		Domestic	Foreign	TOTAL
1951	API*	1,940,600	204,910	2,145,510
1951	BM	1,878,600	136,710	2,015,310
Change		62,000	68,200	130,200
% Change		3.3	49.9	6.5

*Through Oct. 25

Source: Compiled from API data

BM Forecast of Crude Runs to Stills, 1952
(July 28, 1952; 1000 b/d avg. by quarters)

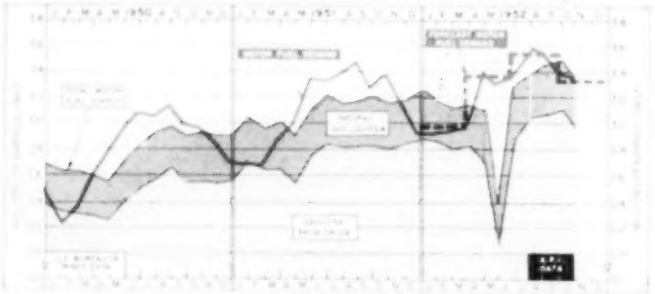
Actual		Estimated		Forecast	
1951 Q	6,930	2952 Q	6,918	3953 Q	6,850
2952 Q	6,956				

Yields on Crude Runs to Stills

		Gasoline	Kerosine	Dist. Fuels	Resid Fuels
		%	%	%	%
1951	API*	45.1	7.5	25.5	17.5
1952	API*	44.1	7.5	25.5	17.5
1951	BM	44.1	7.5	25.5	17.5
1952	BM	44.1	7.5	25.5	16.8

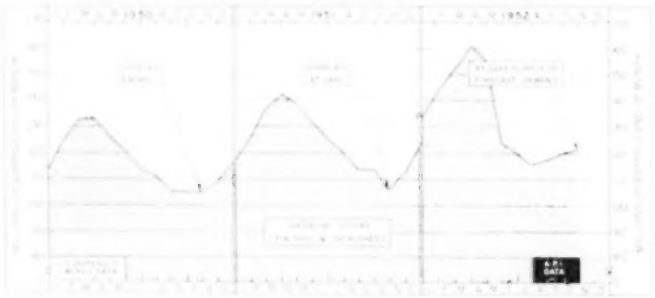
*Through Oct. 25

Fig. 2—Decrease in Refinery Gasoline Output



*Natural Gas Liquids include gasoline blended at refineries, and that used as finished motor fuel.

Fig. 3—Little Change in Gasoline Stocks



*New basis for reporting added approximately 9,000,000 bbls. to primary stocks.

Fig. 4—Stronger Upswing in Heating Oil Demand

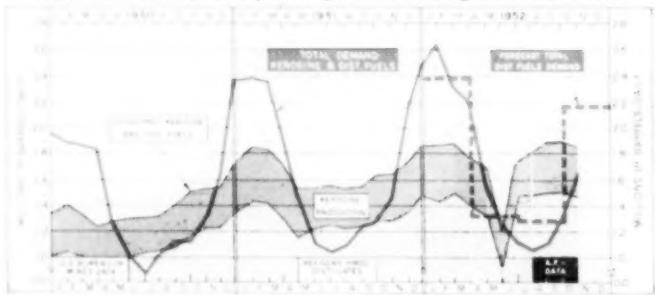
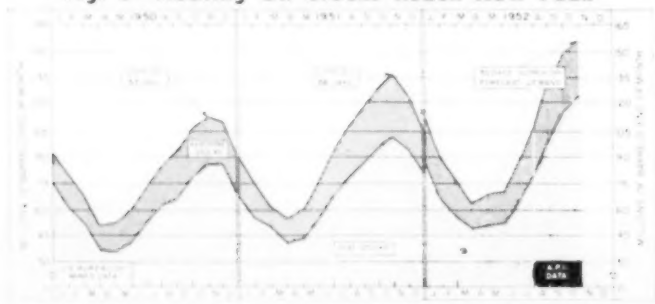


Fig. 5—Heating Oil Stocks Reach New Peak



*New basis for reporting added approximately 4,500,000 bbls. to primary stocks.

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
1951 — API*			
1951 — BM			
Change			
% Change			
*Through Dec. 20			
Total (1000 bbls.) (Bureau of Mines Data)			
1951			
1952			
Change			
% Change			

*Supplement estimated from API data.

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

1951 — API*	
1951 — BM	
Change	
% Change	
*Through Dec. 20	
Total (1000 bbls.) (Bureau of Mines Data)	
1951	
1952	
Change	
% Change	

*Supplement estimated from API data.

BM Forecast of Motor Fuel Demand, 1952
(July 28, 1952, 1000 b/d avg. by quarters)

Actual				
Forecast				

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

1951 — API*	
Sept. — API	
Nov. — BM	
Dec. — BM	
Dec. 31	

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
1951 — API*			
1951 — BM			
Change			
% Change			
*Through Dec. 20			
Total (1000 bbls.) (Bureau of Mines Data)			
Sept.			
Sept.			
Change			
% Change			

*Supplement estimated from API Data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
1951 — API*			
1951 — BM			
Change			
% Change			
*Through Dec. 20			
Total (1000 bbls.) (Bureau of Mines Data)			
Sept.			
Sept.			
Change			
% Change			

*Supplement estimated from API Data

BM Forecast of Heating Oils Demand, 1952

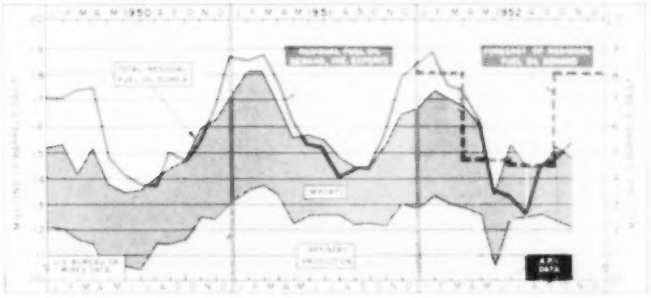
Actual				
Forecast				

Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
1951 — API*			
Sept. — API			
Nov. — BM			
Dec. — BM			
Dec. 31			

Fig. 6—Upturn in Residual Fuel Demand



Residual Fuels Production

Daily Average (1000 bbls.)

		R-Binery Output	Imports	TOTAL
1951	12 API*	1,297	243	1,540
1951	12 BM	1,324	213	1,537
1952	1	1,322	213	1,535
1952	2	1,322	213	1,535
1952	3	1,322	213	1,535
1952	4	1,322	213	1,535
1952	5	1,322	213	1,535
1952	6	1,322	213	1,535
1952	7	1,322	213	1,535
1952	8	1,322	213	1,535
1952	9	1,322	213	1,535
1952	10	1,322	213	1,535
1952	11	1,322	213	1,535
1952	12	1,322	213	1,535
1951	4 Quarter	1,322	213	1,535
1952	1 Quarter	1,322	213	1,535

Total (1000 bbls.)
Barrels of Motor Data)

Sept.	1951	38,122	6,422	44,544
Sept.	11	38,829	6,145	44,974
1 Quarter		116,102	19,422	135,524
1 Quarter		116,102	19,422	135,524

*Preliminary estimated from API data.

Residual Fuels Demand

Daily Average (1000 bbls.)

1951	12 API*		1,510
1951	12 BM		1,550
1952	1		1,550
1952	2		1,550
1952	3		1,550
1952	4		1,550
1952	5		1,550
1952	6		1,550
1952	7		1,550
1952	8		1,550
1952	9		1,550
1952	10		1,550
1952	11		1,550
1952	12		1,550
1951	4 Quarter		1,550
1952	1 Quarter		1,550

Total Demand (1000 bbls.)

Sept.	1951		42,000
Sept.	11		44,000
1 Quarter			44,000
1 Quarter			44,000

*Preliminary estimated from API data.

BM Forecast Residual Fuels Demand, 1952
(July 28, 1952, 1000 b.d. avg. by quarters)

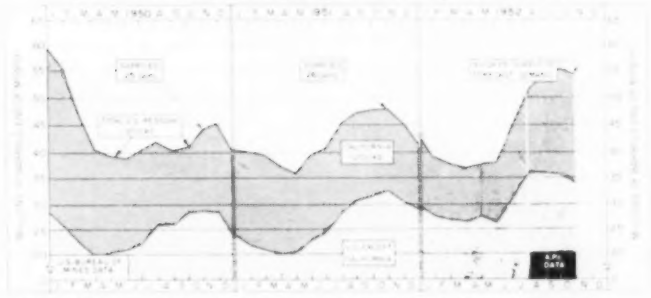
1	1,421	1,421	1,421	1,421	1,421
2	1,421	1,421	1,421	1,421	1,421
3	1,421	1,421	1,421	1,421	1,421
4	1,421	1,421	1,421	1,421	1,421
5	1,421	1,421	1,421	1,421	1,421
6	1,421	1,421	1,421	1,421	1,421
7	1,421	1,421	1,421	1,421	1,421
8	1,421	1,421	1,421	1,421	1,421
9	1,421	1,421	1,421	1,421	1,421
10	1,421	1,421	1,421	1,421	1,421
11	1,421	1,421	1,421	1,421	1,421
12	1,421	1,421	1,421	1,421	1,421

Residual Fuel Stocks

(000 bbls. end of month)

		U.S. Except California	TOTAL U.S.
1951	12 API*	41,000	44,000
1951	12 BM	41,000	44,000
1952	1	41,000	44,000
1952	2	41,000	44,000
1952	3	41,000	44,000
1952	4	41,000	44,000
1952	5	41,000	44,000
1952	6	41,000	44,000
1952	7	41,000	44,000
1952	8	41,000	44,000
1952	9	41,000	44,000
1952	10	41,000	44,000
1952	11	41,000	44,000
1952	12	41,000	44,000

Fig. 7—30 Days' Supply of Heavy Fuel Stocks



*New basis for reporting added approximately 1,500,000 bbls. to primary stocks.

Fig. 8—Supply and Demand of Natural Gas Liquids

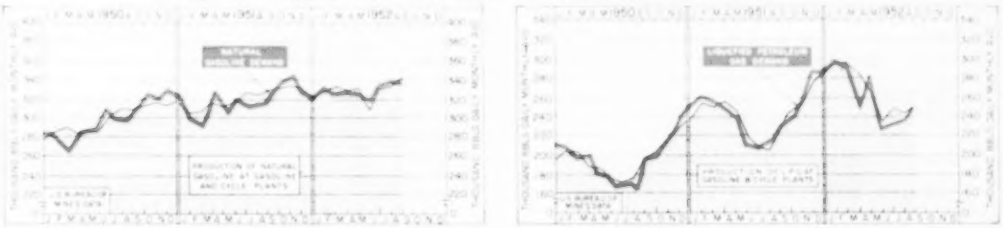
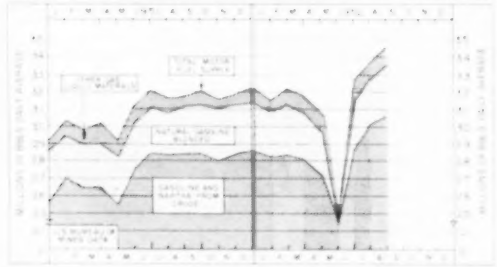


Fig. 9—Makeup of U.S. Motor Fuel Supply



(Figures in table in 1000 bbls. day average)

		Gasoline & Naphtha from Crude	Natural Blended	Other Gas Liquid Materials	Total Motor Fuel Supply
1951	12	2,000	200	100	2,300
1951	12	2,000	200	100	2,300
1952	1	2,000	200	100	2,300
1952	2	2,000	200	100	2,300
1952	3	2,000	200	100	2,300
1952	4	2,000	200	100	2,300
1952	5	2,000	200	100	2,300
1952	6	2,000	200	100	2,300
1952	7	2,000	200	100	2,300
1952	8	2,000	200	100	2,300
1952	9	2,000	200	100	2,300
1952	10	2,000	200	100	2,300
1952	11	2,000	200	100	2,300
1952	12	2,000	200	100	2,300
1951	4 Quarter	2,000	200	100	2,300
1952	1 Quarter	2,000	200	100	2,300

Natural Gas Liquids Statistics

Supply* (1000 bbls. day avg.) Demand** (1000 bbls. day avg.)

		Natural Gasoline	LPG	TOTAL	Natural Gasoline	LPG	TOTAL
1951	12	140	240	380	200	240	440
1951	12	140	240	380	200	240	440
1952	1	140	240	380	200	240	440
1952	2	140	240	380	200	240	440
1952	3	140	240	380	200	240	440
1952	4	140	240	380	200	240	440
1952	5	140	240	380	200	240	440
1952	6	140	240	380	200	240	440
1952	7	140	240	380	200	240	440
1952	8	140	240	380	200	240	440
1952	9	140	240	380	200	240	440
1952	10	140	240	380	200	240	440
1952	11	140	240	380	200	240	440
1952	12	140	240	380	200	240	440
1951	4 Quarter	140	240	380	200	240	440
1952	1 Quarter	140	240	380	200	240	440

Total Supply (1000 bbls.) Total Demand (1000 bbls.)

Sept.	1951	42,000	72,000	114,000	60,000
Sept.	11	42,000	72,000	114,000	60,000
1 Quarter		126,000	216,000	342,000	180,000
1 Quarter		126,000	216,000	342,000	180,000

Stocks, End of Month (1000 bbls.)

		By Type of Product				By Location			
		At Gasoline plants and Terminals only							
		LPG	Natural Gasoline	Cond. Gasoline	Fractionated Gasoline	Gasoline Plants	Refineries	Total
1951	12	2,000	1,000	500	1,500	3,000	2,000	5,000
1951	12	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	1	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	2	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	3	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	4	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	5	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	6	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	7	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	8	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	9	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	10	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	11	2,000	1,000	500	1,500	3,000	2,000	5,000
1952	12	2,000	1,000	500	1,500	3,000	2,000	5,000

*Includes natural gasoline and cycle products.

**Includes exports and stock changes.

ADVERTISERS' INDEX

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Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

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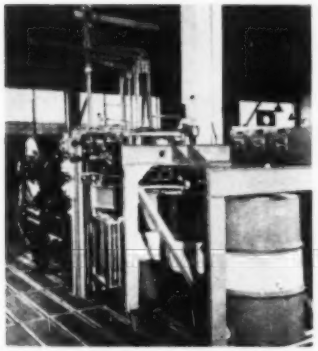
WHAT'S NEW . . .



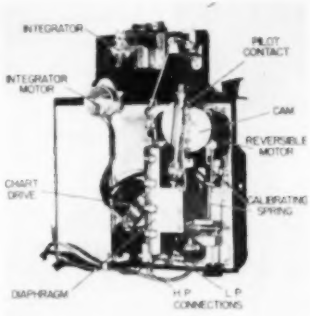
1000 Drums per 8-hr. Shift Is Rate of Automatic Filling Device

An automatic drum filler for oils and other liquids, capable of filling 1,000 drums of 53-55 gal. capacity per eight-hour shift with a single operator has been announced as being in its second year of operation in the lubricating oil department of a major refinery. Empty drums are fed to the unit by gravity roller conveyor. The filler admits one drum at a time, automatically locates the bung and positions the drum. Wide variations in drum heights, diameter and bung locations can be accommodated automatically. A filling lance descends through the open bung, automatically opening the filling valve at the bottom of the stroke. Filling is done "from the bottom up," with the lance tip submerged to minimize foaming and static spark. A dial scale, pre-set to the desired net filling weight, automatically compensates for the tare weight of the drum and provides automatic cut-off when the pre-set net weight is reached. The lance then withdraws and a drip pan swings under the tip; drum heads are kept clean and dripped liquid is returned to the filling line. Once the unit is started, it is under automatic control and cannot be stopped except manually by the operator. Interlocking controls provide automatic cut-off if empty drums are not received at the unit, or filled drums not moved off the delivery conveyor. The Rucker Co., 4228 Hollis St., Oakland 8, Calif.

Circle No. 1 on Reply Card

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.



Differential Flow Meter Uses Diaphragm Measuring Element

The "Diaflow Meter" is a newly-designed low differential flow meter for measuring air flow, gas flow or recording the ratio of air flow to gas flow. The instrument utilizes the pilot method of operation in which no load is placed on the measuring element. Because it uses a dry diaphragm type measuring element no water, oil, or mercury are required and leveling is thereby eliminated. Internal parts are accessible from the front and can be replaced without special tools. In addition to measuring a single flow, two flow elements can be provided so that the gas and air flow records can be combined and coordinated for efficient combustion. The measuring element will accommodate static pressures up to 10 psi. and differential pressures to 20-in. of water. A single heavy duty fine silver wiping contact converts the diaphragm differential into an electrical impulse which energizes the reversing motor to provide the power required for the meter. The capacitor type motor which is specially built for this "reversing duty" has a squirrel cage rotor and a fully enclosed lubricated gear train. To provide ease of flow reading, a cam is incorporated to change the square root relationship between differential pressure and flow to an easily read equal-increment flow record. The Hays Corp., Michigan City, Ind.

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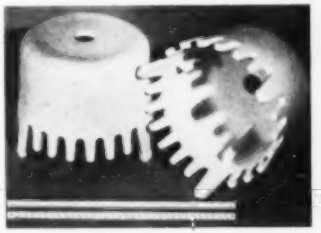


Ceramic Bubble Caps Developed For Use in Severe Corrosives

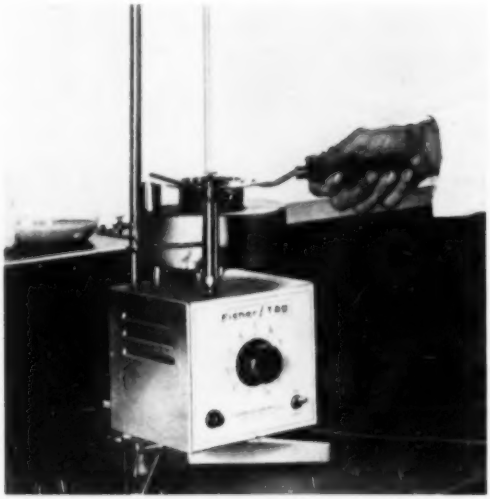
Bubble caps of high strength ceramic are now being manufactured for general use in fractionating and distillation towers where severe corrosion limits the useful service life of metal caps. The caps are made of Coors Type AB-2 high alumina ceramic which has a tensile strength of 18-20,000 psi and a compressive strength in excess of 200,000 psi. In factory tests of physical strength, failure occurred at a load of 24,000 psi on the caps, which are 8¾-in. O. D. by 7-in. high with a ⅝-in. wall. Hydrofluoric acid and strong caustic solutions are about the only corrosive media which will affect the ceramic bubble caps, claims the manufacturer. Landes, Zachary and Peterson, sales representatives for Coors Porcelain Co., 2500 West 7th Ave., Denver 4, Colo.

Circle No. 3 on Reply Card

New Oxygen Analyzer Designed Specifically for Combustion Use

The Beckman oxygen analyzer, Model F-3, is designed specifically for combustion applications in petroleum refineries, power plants, etc., to indicate the oxygen content of flue or process gases automatically. Basic operating principle is the use of the paramagnetic property of oxygen. Accuracy is said to be within 1% of full scale for spans of 5% or greater. Combustion ranges include 0-5, 0-10, 0-15%, and are supplied with a second range of 25%. Others to 0-100% are available. A positive check of proper operation is made by recording the air-point on the second range. Any standard potentiometer recorder, controller, or pneumatic receiver can be used with the F-3. Arnold O. Beckman, Inc., 1020 Mission St., South Pasadena, Calif.

Circle No. 4 on Reply Card



OPEN CUP FLASH TESTER makes ASTM D92 test much easier

KINEMATIC VISCOSITY BATH for ASTM D445 tests

Lab Items Facilitate ASTM Tests

Fisher Scientific Co. has developed equipment and instrumentation to aid the petroleum chemist in meeting American Society for Testing Materials specifications in: 1) determining flash and fire points as given in designation D92, 2) temperature control in viscosity tests covered by ASTM D445 using Ubbelohde reverse-flow or Ostwald-Fenske viscometers, and 3) temperature control in the determination of foaming characteristics of crank case oils as outlined in ASTM D892.

Three Open Cup flash point testers have been completely redesigned to meet ASTM D92 specifications. Their design makes them easy to move from one laboratory to another. Gas and electric heaters are now integral parts of the stand assembly, with gas inlet mounted in the rear at the bottom of the stand. One short piece of rubber tubing connects the gas inlet to the bench gas tap. A smaller grid has been substituted so that the flame will not backfire at the slow ASTM heating rate (to be adjusted to 9-11° F. per minute by the operator). Stand and control box are finished in a polychrome gray resin. Remaining parts are chrome plated.

The sample cup is a casting, not a forging, and is much less susceptible to thermal distortion. Further consideration of the burnt finger theme prompted a redesign of the sample cup. The handle is now made of stainless steel tubing to reduce the heat conducted from the hot cup to the grip. An adjustable test flame torch, pivoted in a special clamp, is provided in both electric and gas models for swining the test flame across the center of the cup at the distance from the surface of the sample specified by ASTM. A small bead (5/32-in. in diameter) is mounted near the pilot light for comparison in adjusting the test flame size. The Open Cup Flash Tester comes in two electrical models, and a gas model which uses either artificial or natural gas.

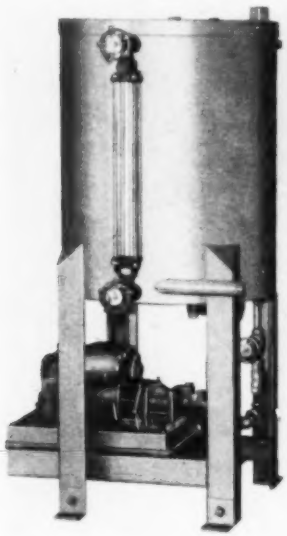
Items 2 and 3 above refer to unitized bath systems for specified ASTM tests. A heavy cast-metal base and a Pyrex brand glass jar constitute a fundamental bath assembly. Fisher has developed a system whereby other units are added to the basic bath assembly as needed. Baths can be held at constant temperatures over a 20-200° C. range with a combination of the several available heaters, cooling coils, stirrers and thermoregulators. Fisher has available the two ready-made unitized baths to perform many prescribed ASTM tests. The baths come with a choice of two thermometer units for the user, one covering the range from —20° to 110° C. and the other from —10° to 200° C. These come complete with special Castaloy clamps that fit the top of the bath jar. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Circle No. 5 on Reply Card

Round-Chart Recorders Added To Line of Electronic Units

Round-chart recorders and automatic controllers have been added to a line of electronic "Dynamaster" potentiometers and bridge instruments. Manufacturer claims the new models are accurate, high-speed, continuous-balance, null-type electronic instruments which can be used to measure any variable that can be translated into an electrical quantity such as dc current, dc voltage, capacitance, or resistance. Typical sensing elements that can be used with the new instruments include thermocouples, radiation detecting units, resistance thermometer bulbs, pH amplifiers, tachometer magnetos, strain gauges, smoke density detectors, thermal converters for power measurements, beta ray gauges, and many others. The instruments are housed in a moisture-, fume-, and dust-proof case suitable for wall, flush-panel, or front-of-panel mounting. Universal construction permits complete interchangeability of components. The measured variable is simultaneously recorded on a 12-in. diameter chart and indicated on a large circular scale which is legible at a distance. Models are offered for full-scale pen travel in 7 sec., 3 sec., 1½ sec., or 2-3 sec., and a wide variety of ranges. Models with air and electric control action are also available. The Bristol Co., Waterbury 20, Conn.

Circle No. 6 on Reply Card



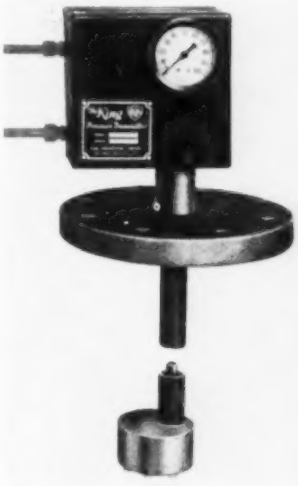
Compact Chemical Feed System Economizes, Cuts Piping Needs

A "packaged" chemical feed system is now available to reduce field piping and realize considerable savings in installation time and space. The unit consists of a 50-to-500 gal. carbon steel chemical solution tank mounted over a controlled volume pump. Piping is supplied for the suction line, complete with valves and sight gage for reading liquid level. Accessory equipment, including agitators, dissolving baskets, low-level alarm panel, electrodes and relays can also be supplied. Controlled volume pumps for the unit are also available in either Simplex or Duplex models, air-powered or motor-driven. Manufactured in ten types of metal, pump capacities of the pumps range up to 300 gph, and operate against pressures up to 5000 psi. Milton Roy Co., 1408 East Mermaid Lane, Philadelphia 18, Pa.

Circle No. **7** *on Reply Card*

New Pressure Transmitter Has Diaphragm For Positive Seal

A pressure transmitter is now available for use with pneumatically-operated instruments for measuring the pressure of liquids and gases where a positive seal is needed between the gaging system and the fluid measured. This pressure transmitter includes a diaphragm that is exposed to the fluid to be measured. The pressure of the fluid on the outer side of the diaphragm is continuously and automatically balanced by the pressure of air supplied to the inner side. This air pressure is transmitted through a pipe or tube to the receiver. Various types of receivers can be used, and if desired two or more receivers may be used at different locations with the same transmitter. The linear response of the transmitter permits readings accurate to ± ¼-in. of water on vented tanks, and ± ½-in. on pressurized tanks. The pressure transmitter is available 1) with flange mounting, for use with the diaphragm inside the tank, and 2) with a union connection, for use with the diaphragm outside the tank. In addition, a combined liquid-pressure and equalizer unit is available, for measuring liquid in pressurized tanks. King Engrg. Corp., Ann Arbor, Mich.



Circle No. **8** *on Reply Card*

DID YOU MISS THESE?

The following items, reviewed originally in the September issue, have aroused considerable interest. They are repeated briefly as a service to those who might have missed them the first time. For details or literature, use the regular Reply Card in this issue.

Cooling Tower Operation

Cooling Towers, Bulletin CT-52-4; 32-page booklet containing details with respect to fan drive, equipment support, floating shaft, speed reducer, water inlet, distribution system, spray eliminators, inlet louvers, etc., with suggestions on recirculation and surroundings; includes inquiry data sheet for users' planning requirements. Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

Circle No. **9** *on Reply Card*

Caustic Soda

Dow Caustic Soda, Form 1C2A 452-70-pages, newly revised, covering 1) manufacture of caustic soda, 2) chemical and physical properties, 3) economics, 4) handling and storage, 5) technical data, 6) methods of analysis, and 7) first aid instructions. Dow Chemical Co., Midland, Mich.

Circle No. **10** *on Reply Card*

Ceramic Fiber Shows Promise As Refractory and Insulation

"Fiberfrax" is a new refractory or ceramic fiber—a vitreous aluminum silicate—now available in a fluffy mass of a random arrangement of extremely fine fibers, with an average thickness of 4 microns and length of 3 in. It can resist temperatures up to 2300° F. and does not soften at up to 3000° F. One of its applications is a lightweight furnace insulation. Two lbs. packed to a 6 lb./cu. ft. density fill the same volume as 14.6 lb. of high-grade refractory insulating brick and furnish the insulating efficiency of 20.9 lb. of the same brick. Possible heat savings are said to make it directly competitive with the brick even at its present pilot-plant price of $1./lb. The Carborundum Co., Niagara Falls, N. Y.

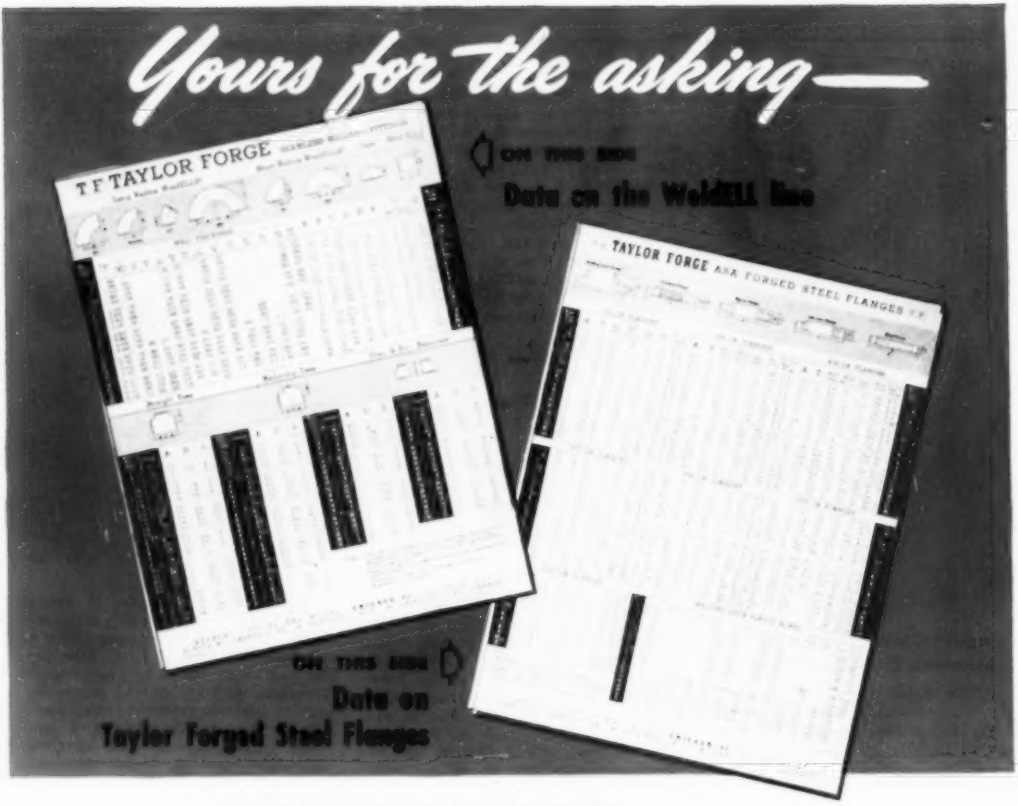
Circle No. **11** *on Reply Card*

No Seals or Stuffing Boxes In New Centrifugal Pump Design

"Chempump" is a new magnetically-driven, combined motor and centrifugal pump which requires no mechanical seals or stuffing boxes. It is designed to overcome many of the usual problems associated with the conventional centrifugal pump in handling corrosive and hazardous fluids. It is expected to find a wide variety of applications in petroleum and petrochemical processing. Essential feature of the pump is that the fluid being handled can come into contact with all parts except the motor stator, which is kept isolated by a non-corrosive, non-magnetic, and highly electrical-resistant, stainless steel sleeve in the air gap space between stator and rotor. Chempump Corp., 1300 East Mermaid Lane, Philadelphia 18, Penna.

Circle No. **12** *on Reply Card*

Yours for the asking—



A VOLUME OF DATA

. . . covering welding fittings and forged steel flanges . . .

ON A SINGLE SHEET

Here is just about the handiest tool ever devised for the pipe designer. Data on welding fittings and flanges that otherwise could be found only by plowing through many catalog pages and tables have been ingeniously condensed on the two sides of the durable letter-size card illustrated above.

One side covers the broad WeldELL line of Taylor Forge welding fittings. For every nominal pipe size, ½" through 30", it shows the wall thickness for every weight of every fitting in every available material. It also shows all required dimensions of all types of fittings.

The other side covers the world's most complete line of forged steel flanges. For every nominal pipe size, ½" through 24", it gives all essential dimensional and bolting data for all types of flanges in all weights. A particularly useful table (see reproduction) is that showing welding neck flange bores which enables you to determine the I.D. of any nominal pipe size without separate calculation. Thus the sheet gives you O.D. and I.D. of any weight of pipe.

The card is varnished to make it stand the steady usage you are certain to give it. To obtain your copy see your Taylor Forge distributor or **MAIL THE COUPON.**

Please send me one of your fitting and flange sheets

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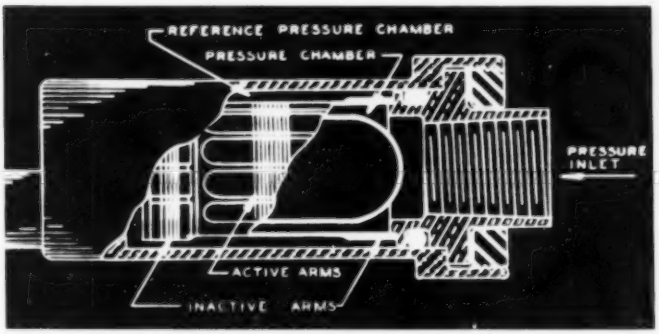
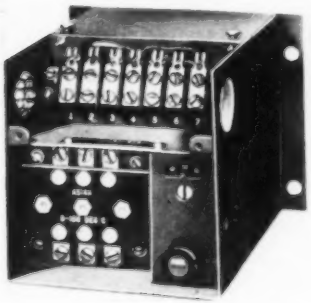
Offices in all principal cities
Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada



Pressure Surges No Problem

Extremely rapid transient pressure surges and high-frequency pressure pulsations, encountered in processing operations today, can now be measured accurately and easily with the new Type 4-301 Pressure Transducer, which converts the primary variable to an electric signal. The transducer's output may be recorded on an oscillograph or it may be used to indicate changes on meters or oscilloscopes, which can be monitored visually or photographed. Overloads will not cause mechanical failure in the pickup. In operation, pressurized liquid or gas enters a fluted, pressure-sensitive cylinder, about which are wound the active arms of a four-arm bridge circuit. The cylinder dimensions change in exact proportion to even minute pressure variations. These changes, in turn, alter the resistance of the wire wound around the cylinder, resulting in a measurable bridge-unbalance voltage. Output is linear within ±0.5% of full scale. The unit, complete with cable and a plug, weighs 9 ounces and measures 1⅛ in. in diameter. Initial instruments are designed for 10 psig. operation. Later models will be available with full-scale ranges to 5000 psig., and can be constructed of materials suited to pressure problems in chemical, petrochemical, and petroleum processing. Consolidated Engrg. Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

Circle No. **13** *on Reply Card*



Adjustable Temperature Ranges Designed Into New Transmitter

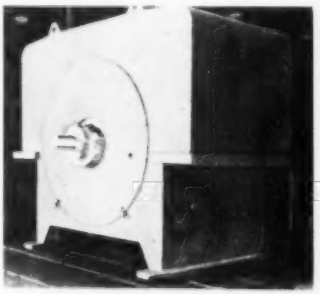
The Type T2T Autronic Temperature Transmitter is a new electronic component for the Swartwout all-electronic control systems. It consists essentially of two major assemblies: resistance thermometer element and an adapter unit (shown in the illustration). The thermometer element is made of pure platinum wire wound on a ceramic core and sealed in an Inconel tube. Standard thermowell, lagging extension thermowell, or finned thermowell styles are available. The adapter unit converts resistance changes to a proportional signal voltage which varies from 0 to 0.5 volts, 60 cycles, A.C. for the full range of the measuring element. A three-wire system connecting the two elements compensates for variations in lead wire resistance with ambient temperature change. A special adjustment is provided in the adapter to compensate for minor variations in thermometer element resistance. The adapter unit features a removable range card giving fourteen 50° C. spans from −50 to 325° C., six 100° spans from −50 to 300° C., three 200° spans from −100 to 300° C., or one 300° span from −50 to 250° C. Similar range spans are also available in Fahrenheit. The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Circle No. **14** *on Reply Card*

Highly Porous Ion Resin Helps Catalysis of Organic Reactions

An ion exchange resin, "Amberlite IR-112 (H)," is now available to laboratories ready for immediate use in laboratory exchange columns. The resin consists of tiny pieces of nuclear sulfonic acid and has an acid strength about equal to sulfuric acid; however its structure permits only hydrogen ions to move into solution. Having unusually high porosity, the material has special importance in the treatment of non-aqueous fluids, catalysis of organic reactions, recovery of large cations from waste and process solutions, and operations in the hydrogen cycle. Its uses in organic catalysis: it is claimed to replace mineral acids in the synthesis of acetals; esterification; conversion of acetone and hydrolysis of alkylene oxides. The new Amberlite's insolubility makes synthesis vial column operation most convenient by: 1) continuously passing reactants into the top of the resin column, 2) drawing reaction products from the bottom. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Circle No. **15** *on Reply Card*



Lower Air Intake Velocity Stops Rain's Entry in Motor Windings

An outdoor weather-protected motor which carries protection much further than the splashproof type has been designed to keep wind-driven heavy moisture out of its windings. Its intake velocity has been reduced to less than 600 ft./min., so heavy rain particles cannot be drawn into the motor. Air moves vertically upward through side intakes into a greatly expanded air space, further lowering its velocity. Rain gutters are provided on the sides of the air intakes, draining through pipes to the ground. Air intakes are located at considerable heights above ground level, thus dust and dirt are prevented from entering the machine during periods of dry weather. No special concrete foundation or base is required for the motor, which

For *Extra* Fast Easy Smooth Pipe Threading Choose

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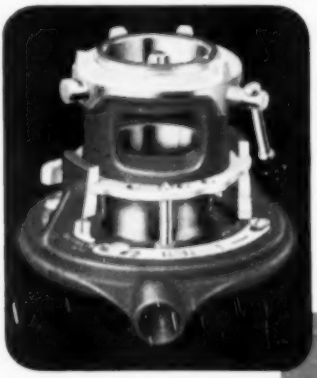
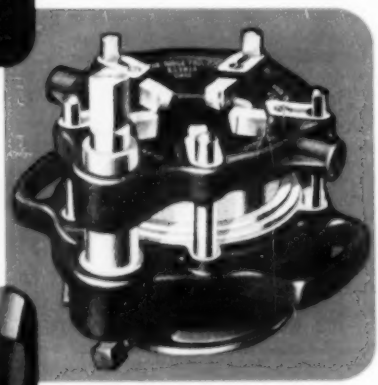


Work-Saver Die Stocks

JAM-PROOF 65R

Perfect threads on 1" to 2" pipe with 1 set of 4 high-speed steel dies—sets to pipe size in 10 seconds. Lead screw on barrel won't jam on workholder—drive plate automatically kicks out driving pawl. Self-centering workholder sets instantly!



4P GEARED THREADER

For 2½" to 4" pipe. Balanced loop handles—easy to lift 4P where you want it. Mistake-proof workholder sets to size before put on pipe—1 set screw. Safe enclosed gear. Practically no upkeep. Special 4P for conduit.

OOR RATCHET THREADER

For ⅛" to 2" pipe. Heads snap into ratchet ring from either side, won't fall out. Precision-cut alloy dies reverse for close-to-wall threads. 00R and 0R, ⅛" to 1"; 111R and 11R, ⅛" to 1¼"; 12R, ⅛" to 2". Conduit dies, too.

EXTRA VALUE

RIDGID's are famous for efficient design, smooth performance, rugged durability. Every die stock factory tested. For top value for your money, buy RIDGID threaders from your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

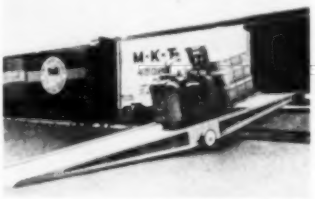
RIDGID

Work-Saver Pipe Tools

What's New!

is available in the full range of ratings required for major auxiliary drives, including boiler feed pumps. Allis-Chalmers Manufacturing Co., General Machinery Div., Milwaukee 1, Wisconsin.

Circle No. **16** *on Reply Card*



Portable Yard Ramp Solves Materials Handling Problem

A portable magnesium yard ramp has been introduced to solve a materials handling problem. The problem is one of loading and unloading freight cars from ground level when dock facilities are not available or existing facilities are congested. The portable yard ramp may be obtained in five standard sizes, all of which are 30 ft. long but vary in widths of 60 and 70-in. Capacities range from 6,000 to 16,000 lbs., capacity being the combined weight of the load and the materials handling equipment transporting the load over the yard ramp. Quarter-round safety curbs with inner edges rounded to protect equipment are used along the top sides of the ramp. The ends of these curbs are capped with an end casting which tapers to each corner of the ramp. Bridge type underbracing offers maximum strength with minimum weight. In use the ramp is positioned in front of the freight car door and one end is raised by means of a hydraulic jack. The lower end of the ramp is on the ground which prevents it from being forced out of the car during loading operations. Magnesium Co. of America, 1515 N. Kilpatrick Ave., Chicago 51, Ill.

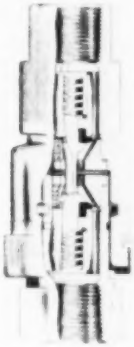
Circle No. **17** *on Reply Card*

Pressure Transmitter Has Kel-F Diaphragm to Resist Corrosives

Using a corrosion-resistant Kel-F diaphragm, the new Type 40 Isolator provides a means for pressure transmission with negligible pressure drop of highly corrosive fluids, since it separates the corrosive from the balance of the instrumentation system. The unit will operate at line pressures up to 1000 psi, and other models are available for operating at up to 3000 psi. Trans-Sonics, Inc., Bedford, Mass.

Circle No. **18** *on Reply Card*

Quick Coupler Can Be Used On Hydraulic and Pneumatic Lines



A make and break double shut-off valved coupler has been designed and introduced for wide industrial applications including use where pneumatic or hydraulic lines are involved. As the two halves of the unit are coupled together, the two piston valves open by moving away from their respective seats. A soft molded insert, mechanically held in place, forms the seat in each half of the coupler. True alignment of pistons is insured by long guides. Seat bushings can be unscrewed to replace pistons after long service. An "O" ring in the socket half provides positive seal while the coupling is connected. Protector caps are provided for covering coupler halves when disconnected. The coupler is available in ½-in. F. P. T. connections. Henry Valve Co., 3215 North Avenue, Melrose Park, Ill.

Circle No. 19 on Reply Card

Moisture In Petroleum Products Determined Electro-Magnetically

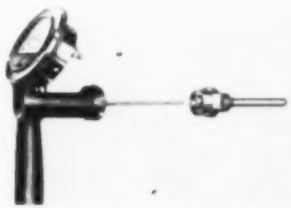
Utilizing the Karl Fischer method for determining moisture content in petroleum products, the "Aquameter" is claimed to be outstanding for its speed, reproducibility and ease of operation. Fully automatic, it makes possible the completion of either direct or back titrations in a matter of one or two minutes with a precision of 0.05 ml., or better, obtainable even where simultaneous extraction and titration are required. Designed into the new unit is an alternating-current, null detecting amplifier circuit which responds to change in the resistance between the electrodes due to a decrease in the polarization as the end-point of titration is approached. During titration, Karl Fischer reagent is added to the sample solution by means of a burette and regulated by the electro-magnetic valve. The amount of current flowing through the aqueous solution during titration is detected by a circuit which energizes this valve and thus maintains it in a position which permits reagent to enter the solution. At the end-point, with moisture no longer present in the solution, the electrodes suddenly depolarize, the current increases rapidly, and the valve cuts off the flow of reagent. A timing device, preset before titration is begun, enables the instrument to distinguish between a true and a false end-point and assures reproducible results. A selector switch converts the circuit for back titrations and permits the flow of water-methanol to be halted electromagnetically at the end-point by an attendant decrease, rather than increase, of current. Beckman Instruments, Inc., 820 Mission St., South Pasadena, Calif.

Circle No. 20 on Reply Card

Electronic Controls Adjust For Slight Temperature Changes

"Thermo Electronic" Temperature Controllers, which use resistance bulb sensitive elements, have been developed for controlling operating temperatures from −100° F. to +600° F. Built with single or duplex control action, they are available in six different temperature ranges. The instrument features: a relay with load contacts for operating heating elements, motor starters, electric valves, and signal contacts for the two red and green lights on the instrument door. These signal lights are visible over a wide angle at distances up to 100 ft. When the temperature at the resistance bulb deviates as little as 0.1° F. from the control point setting, corrective action is instantaneous. Calibration of the measuring circuit is accurate within ±0.25% of the scale range. This accuracy is maintained by stabilized manganin wire resistors. The circuit is immune to electrical interference encountered in induction heaters and spot welders. The control relay is the sole moving part of the instrument and operates completely on A. C. current. Standard vacuum tubes are used in the electronic circuit. Thermo Electric Co. Inc., Fair Lawn, N. J.

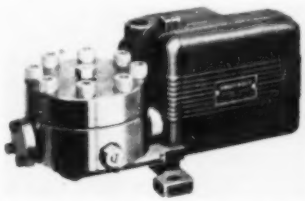
Circle No. 21 on Reply Card



Portable Pyrometer Checks Diesel Engine Temperatures

A portable diesel engine pyrometer has been designed for test purposes and for installations where no permanently mounted pyrometer is available. With this instrument, thermocouples are installed in each cylinder and in the main exhaust line. Temperatures can then be checked at any time by inserting the pyrometer prongs into the corresponding receptacles in the terminal head of the thermocouple. Designated as "Model 4-321", the new pyrometer has a 0 to 1000° F. temperature range. Zero adjustment is on the outside of the case and no external source of power is required. The Bristol Co., Waterbury 20, Conn.

Circle No. 22 on Reply Card



Transmitter Has Seal To Act Against High-Static Pressures

The "Type D2T Autronic Differential Pressure Transmitter" is now available for use in Autronic control systems. The transmitter covers a differential pressure range from 0-20 in. to 0-200 in. water at static pressures up to 1500 psig. Installed at the point of measurement, the unit transmits an electric signal which is directly proportional to the variable being measured. The transmitter has a corrosion-resistant stainless steel diaphragm. Minute movements of the diaphragm are transmitted through a friction-free amplifying linkage to the movable core of the differential transformer which provides the signal output required for operation of other units in the sys-

PETRONATE*
(Oil Soluble)

PYRONATE*
(Water Soluble)

HYPONATE*
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PETROLEUM SULFONATES
. . . made to your specifications
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What's New!

tem. The transmitter features a unique anti-thrust pressure seal which transmits motion of the sensing diaphragm to the signal-generating differential transformer, and acts as a seal against high-static pressures. The unit incorporates a spring for zero adjustment, a linkage-ratio adjustment for coarse span, and an electrical adjustment for fine span which does not affect the zero adjustment. The transmitter unit measures 13-in. in length, is 6½-in. high, and 5⅝-in. deep. Net weight is 26 lbs. Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Circle No. 23 on Reply Card

Trade Literature

Planning Plant Locations

Factors Influencing Industrial Plant Location; 12 pages covering subjects directed toward management in planning new plant sites, e.g., production materials, marketing, transportation and distribution, labor, supervision, utilities, service and fuels, bank facilities, laws and taxes, community attitude toward industry, living conditions, climate, national defense, and site characteristics. Walter Kidde Constructors, Inc., 140 Cedar St., New York 6, N. Y.

Circle No. 24 on Reply Card

Solvent Extractors

Podbielniak Inc., Brochure No. 10, 16 pages showing a variety of uses of centrifugal counter-current solvent extractors operating in a number of leading industries, and a description of the "Fractioneer," a completely engineered pilot and small scale production fractionating plant which utilizes a forced circulation vaporizing system. Podbielniak Inc., 341 E. Ohio St., Chicago 11, Ill.

Circle No. 25 on Reply Card

Removing Water Vapors

Dehydrators for Continuous Removal of Water Vapor From Air and Other Gases, Bulletin SC-1013; 12-page brochure describes three series of dehydrators with full specifications on capacities and physical dimensions; includes a nomograph for preliminary determinations of appropriate equipment. Selas Corp. of America, Philadelphia 34, Pa.

Circle No. 26 on Reply Card

Motors for Hazardous Areas

Explosion-Proof Motors, Bulletin 800; 12-page brochure describing a broad selection of motors in ratings from ½ to 450 hp for single or polyphase A.C. and D.C. applications in hazardous areas; includes photographs of a few of their installations. Louis Allis Co., Milwaukee 7, Wis.

Circle No. 27 on Reply Card

What's New!

Gate Valves

Edward Cast Steel Gate Valves, Catalog No. 12-E; five-page folder describing the features of cast steel gate valves, with details of design, dimensional data, material specifications, ratings, and engineering drawings; catalog includes valves in 300, 600, 900 and 1500 lb. sp classes, furnished in sizes from 2½-in. through 12-in. Edward Valves Inc., East Chicago, Ind.

Circle No. 28 on Reply Card

Tube Expanding Machine

Tube Rolling, the Vernon-Ormrod Method; a four page description of a tube expanding tool which expands and rolls tubes into tubesheets by a controlled method, which is performed by an automatic machine driving the tube-expanding tool. Vernon Tool Co. Ltd., 1101 S. Meridian Ave., Alhambra, Calif.

Circle No. 29 on Reply Card

Petrochemical Catalog

Eastman Industrial Chemicals, Sixth Edition; 33 pages giving specifications, properties and typical uses of some 54 chemicals produced in whole or in part by the Texas Eastman Co.'s Longview, Tex. petrochemical plant; divided into four sections, the catalog is devoted to aliphatic chemicals, aromatic chemicals, cellulose products and inorganic chemicals. Tennessee Eastman Co., Chemical Sales Div., Kingsport, Tenn.

Circle No. 30 on Reply Card

Electrically Operated Valves

Extra Rugged Alkomatic Valves, Electrically Operated; four-page bulletin illustrating packless, electrically operated valves with operating pressures to 3,000 psi, for automatic or remote control; includes operating instructions and information on uses and applications. Alkomatic Valve Co., 545 W. Abbott St., Indianapolis, Ind.

Circle No. 31 on Reply Card

Oxygen-Nitrogen Generators

Make Your Own Oxygen and Nitrogen From Air, Catalog No. 52; 12-page booklet illustrating three types of generating equipment for the production of oxygen, nitrogen, argon and other gases from atmospheric air; includes performance data and flow diagrams of the various generator series. Air Products Inc., P. O. Box 538, Allentown, Pa.

Circle No. 32 on Reply Card

Insulated Pipe

Durant Pre-Sealed Insulated Pipe, Bulletin 6C Du; four-page folder describing a pressealed insulated conduit for underground and weather-exposed piping systems with steam pressures up to 1000 psi; gives con-

For Heavy Duty low cost operation

"International" AGITATOR DRIVE HEADS AND TURBINES

WITH ECONOMY BELT DRIVE - INTERCHANGEABLE SPEEDS - FACTORY ASSEMBLED—ALIGNED - FOR OPEN OR CLOSED TANKS

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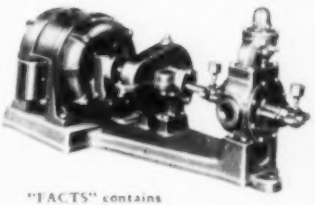

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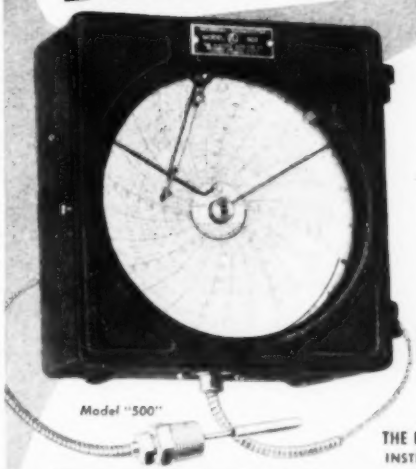

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Temperature Recorder with capillary tubing for EYE-LEVEL reading. Priced from $42.50

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★ This low-cost protection gives permanent proof of temperature behavior.

★ Various standard chart ranges from minus 40°F. to plus 550°F.

★ 3 standard types; choice of 24-hr. or 7-day cycle

Send for new catalog G-143-B, describing many styles of Auto-Lite temperature indicators and recorders.

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TEMPERATURE RECORDERS & INDICATORS

struction and fabrication details, standard specifications, field joint procedure, and applications. Durant Insulated Pipe Co., P. O. Box 88, Warren Way and Bay Rd., Palo Alto, Calif.

Circle No. **33** *on Reply Card*

pH Control

Automatic Recording and Control of pH—Hydrogen Ion Concentration, Instrumentation Data Sheet No. 10.7-1; four-page folder covering a system for automatic recording and control of pH with a discussion of measuring system components and adjustments for operation, covers variations in recording and control systems for electric or pneumatic modes of control, and single or multi-point recording. Minneapolis - Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **34** *on Reply Card*

Organic Chemicals Catalog

Eastman Organic Chemicals, List No. 38, 38th Edition; 224-page book, including a new section on nomenclature of organic chemicals, providing data on more than 3,500 organic chemicals with details on chemical structure and molecular weight; includes prices. Distillation Products Industries, A Division of Eastman Kodak Co., Rochester 3, N. Y.

Circle No. **35** *on Reply Card*

Desaponifying Fuel Stocks

Petreco Desaponification Process, four-page bulletin with a flow diagram and description of a desaponification process which removes 85% of the ash-forming constituents from fuel stocks or slag-forming soaps and caustics so that these fuels may be marketed advantageously. Petrolite Corp., Petreco Div., 3202 S. Wayside Dr., Houston 3, Texas.

Circle No. **35** *on Reply Card*

Plastic Pipe & Fittings

Indestructible Plastic Products, Form NY 2260; eight-page brochure gives a description of a new thermoplastic material available as moldings, extrusions and fabrications for pipes and fittings, tanks and fume ducts; includes material's chemical properties, recommended working pressures (for pipes), and a list of various molded industrial parts. New York Belting & Packing Co., 1 Market St., Passaic, N. J.

Circle No. **37** *on Reply Card*

Equipment Data

Process Equipment, Bulletin 2403; 12-page booklet describes electro-vapor heating systems with various dimensions of the units, autoclaves, extraction equipment, contactors, cookers, quick opening doors for pressure vessels, agitator assemblies, resin kettles, and other equipment. Blaw-Knox Co., 2028 Farmers Bank Bldg., Pittsburgh 22, Pa.

Circle No. **38** *on Reply Card*

Lining Protection

Tygon Corrosion-Resistant Linings, Bulletin TL-526; 12-page brochure discusses Tygon's composition as a lining and covering, its physical forms and properties, where and how to apply; also presents maintenance and repair of mechanical damages, and extensive tables on chemical resistance. U. S. Stoneware Co., 60 East 42nd St., New York, N. Y.

Circle No. **39** *on Reply Card*

Centrifugal Compressors

American Blower Centrifugal Compressors, Bulletin 109; 12 pages describing single stage centrifugal blower compressors with 30 to 600 hp ratings, from 1¼ to 3½ psig; covers functions, applications, features of design, arrangements and methods of control. American Blower Corp., Detroit 32, Mich.

Circle No. **40** *on Reply Card*

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OIL REFINERY EQUIPMENT
Natural Gasoline Plants
Chemical Processing Equipment

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Tulsa Type Equipment is designed and fabricated to meet your specified operating conditions.
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Petroleum Research

Battelle Research for the Petroleum Industry, 12-page bulletin tells of the various petroleum research projects conducted by the Battelle Memorial Institute to find uses for petroleum by-products in agriculture, the failure of refinery equipment, cracking catalysis, techniques for welding pipelines, and development of gear lubricants. Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio.

Circle No. **41** *on Reply Card*

Liquid Filters

Stayncw Liquid Filters, Bulletin D-IL; 12-pages containing specifications, engineering and performance data, and descriptions of recommended types of filter media used for water, chemicals, and petroleum products; includes a check list of liquids that can be filtered and a bound-in data sheet designed to aid the user in describing proposed filter installations when contacting the manufacturer. Dollinger Corp., 11 Centre Park, Rochester 3, N. Y.

Circle No. **42** *on Reply Card*

Floor Gratings

4 *"Grates" Serving the Nation's Major Oil Companies*, Form 857; four pages describing diamond riveted, welded, hexteel, and floor-steel gratings used for catwalks, stair treads, ganister linings, runways, and tower stairs; also specifications table with safe loads. Klemp Metal Grating Corp., 1371-75 N. Branch St., Chicago 22, Ill.

Circle No. **43** *on Reply Card*

Level Controllers

Liquid-Level Controllers, Bulletin 2503; 12 page booklet giving operating principles of the packless flexible-shaft type liquid-level controller both in the pneumatic and electric line, with ratings, dimensions, installational features and tips on how to specify when ordering. Moore Products Co., H & Lycoming Sts., Philadelphia 24, Pa.

Circle No. **44** *on Reply Card*

Centrifugal Pumps

Frame Type Centrifugal Pumps, Bulletin 52B6691A; four-page folder describing three frame types of centrifugal pumps with capacities from 85 to 500 gpm, and heads from 70 to 135 ft.; dimensional tables aligned with engineering drawings, and eight charts with performance curves included. Allis-Chalmers Mfg. Co., 836 S. 70th St., Milwaukee, Wis.

Circle No. **45** *on Reply Card*

Liquefying Gases

ADL Mechanical Division Products and Services; 24-page booklet describing helium and hydrogen liquefiers, oxygen plants, helium refrigerators, liquefied-gas storage containers, air coolers; describes the division's services in engineering studies, research and development, and prototype development. Arthur D. Little Inc., Mechanical Div., 30 Memorial Dr., Cambridge 42, Mass.

Circle No. **46** *on Reply Card*

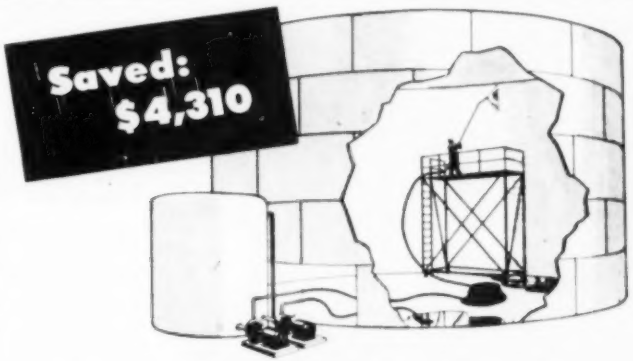
Compressors

M-Line Compressors, Bulletin M-70; 14-page booklet describing the "M-line" multi-stage, multi-cylinder compressors, having from 100 to 5000 hp, 250 to 514 rpm; covers design features, lubricating system, automatic compressor control, motors and drives, and includes space plans and dimensions for the various models. Cooper-Bessemer Corp., Mount Vernon, Ohio.

Circle No. **47** *on Reply Card*

39 Years of Steel Fabrication

Wyatt Metal & Boiler Works; 16-page brochure covering the 39-year history, present mechanical facilities and products of the company; includes descripton of storage facilities.



Storage Tank Cleaned by Own Crew

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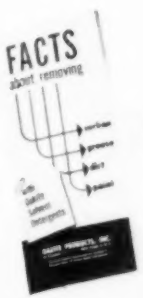
The cleaning is simple. He just sprays an Oakite solvent detergent on tank sides and supporting columns, then follows up with a high pressure rinse. No scraping—no steaming out.

That's the kind of simplicity and economy you get with Oakite solvent detergents. They clean cold, remove tough soils without affecting paint, have long-lasting cleaning power.



FREE BOOKLET gives details; tells how to save time and money on tough cleaning jobs. Get your copy today. Write Oakite Products, Inc., 50D Rector St., N. Y. 6, N. Y.

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If you're looking for the lowest cost, corrosion-resistant tube you can buy, it's called Alcoa UTILITUBE™. (Up to 40% less than other corrosion-resistant metals.)

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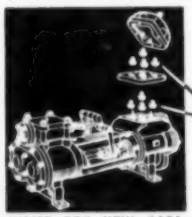
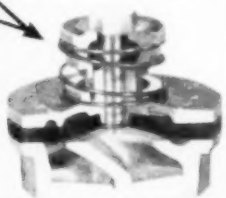
BETTER PUMP PERFORMANCE MEANS *Less Maintenance*

SIMS PUMP

Sims Pump Valves are guaranteed to give you better pump performance. And that means time, money and tempers saved.



1. Discs rotate for minimum wear, while cushioned by liquid top and bottom. 2. Inclined ribbed seat and cushioned stem head combine to give smoother, faster valve action and take up shock.



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What's New!

lay out and cutting of fabricated plate work, fabricating and fitting, welding, machine shop facilities, heat treating, annealing and quenching, and a description with illustrations of field erected work. Wyatt Metal and Boiler Works, P. O. Box 3052, Houston, Texas.

Circle No. **48** *on Reply Card*

Flange Selector

Flange Size Selector, a slide-rule type indicator which lists such facts for Series 15 and 30 Flanges as O. D. of flange, thickness, O. D. of raised face, number of holes, diameter of holes, diameter of bolts, and bolt circle; shows average sizes of standard, extra heavy, 3000-lb. and 6000-lb. couplings, also a convenient pipe standard table showing nominal wall thicknesses and weights per ft. for schedules No. 5 to 160 as well as for standard, extra heavy and double duty extra heavy pipe. Nooter Corp., 1400 S. Second St., St. Louis 4, Mo.

Circle No. **49** *on Reply Card*

Instrument Tubing Supports

Instrot, Bulletin 65-1; four-page folder describing a standard system of prefabricated steel parts for supporting instrument tubing, consisting of sections of flattened expanded steel trough, fittings made of flattened expanded metal, and available in a range of six widths from 3-in. to 24-in., all being 1½-in. high, with a 3-in. radius for flat bends, and 8-in. radius for vertical bends. T. J. Cope Inc., 711 South 50th St., Philadelphia 43, Pa.

Circle No. **50** *on Reply Card*

Spherical Storage Tanks

The Hortonsphere, Bulletin F, eight-page booklet describes Hortonspheres designed for storing liquids and gases, with construction details and principles of operation of each type; includes tables of sizes for the units with capacities ranging from 1,000 to 30,000 bbls. for liquid storage, and 32 to 80 ft. in diameter for storage of gases with operating pressures of 30 to 150 psi. Chicago Bridge & Iron Co., Chicago, Ill.

Circle No. **51** *on Reply Card*

Pneumatic Controller

Pneumatrol, Pneumatic Controller, Catalog C-50; 20-page brochure describing the P-4 "Pneumatrol" controller for rate of flow, differential pressure, liquid level, etc.; usable for either single or dual instrument case mounting and for point-of-measurement installation as well; available in all modes of control with manual or automatic reset and with or without derivative action. Fischer & Porter Co., 6880 Jacksonville Rd., Hatboro, Pa.

Circle No. **52** *on Reply Card*

What's New!

Electrical Equipment

Electrical Equipment for Chemical Processing, Bulletin B-5656; 16-page booklet divided into three main sections—power generation, distribution, and utilization—explains the function of electrical equipment giving only standout characteristics and advantages of each apparatus to the chemical processing industry; where applicable, circuit diagrams, ratings, and installation pictures are presented. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Circle No. **53** *on Reply Card*

New Service Organization

Cambridge Corp.; a descriptive brochure on a newly-created, jointly-owned affiliate of Carrier Corp. and Arthur D. Little, Inc., established to provide a service termed "Transition Manufacturing," providing help in originating a product and following through with design and engineering, limited production, installation, operation, and field testing as well as looking to the product utilization. Write Paul N. Stanton, Cambridge Corp., 444 Somerville Ave., Somerville 43, Mass.

Circle No. **54** *on Reply Card*

Thermocouples and Glands

Bare Wire Thermocouples, Packing Glands, Bulletin TC-1; four pages describing the method of sealing two or more bare wire thermocouples at pressures from full vacuum to 15,000 psi in a pre-formed Neoprene or Teflon gland; gives models available with specifications, suggested applications and information on a midget packing gland. Conax Corp., 4515 Main St., Buffalo 21, N. Y.

Circle No. **55** *on Reply Card*

Reboilers and Condensers

Standard Vertical Thermosyphon Reboilers and Reflux Condensers, Bulletin VTS3-52; four-page folder containing an engineering drawing of a stainless steel vapor condenser with detailed specifications, and a specifications chart on 21 models of vertical thermosyphon reboiler and reflux condensers with all dimensions in inches. Doyle and Roth Mfg. Co. Inc., 136 Twenty Fourth St. Brooklyn 32, N. Y.

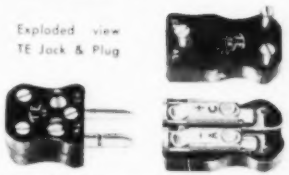
Circle No. **56** *on Reply Card*

Flow Meters and Positioners

Pneumatic Electric Flow Meters, Bulletin 704, and *Pneumatic Positioning Operator, Type SG75LD*, Bulletin S-15; the first bulletin gives some typical applications for the pneumatic electric flow meters which are designed to measure widely fluctuating flows, dirty or corrosive fluids, viscous or vaporous, and dangerous fluids; the latter describes a servomotor which provides positioning of heavy equipment without requiring special pump or return lines, and may

SIMPLIFY THERMOCOUPLE CONNECTIONS

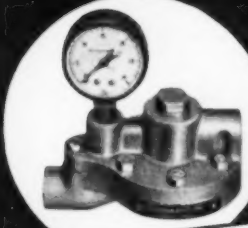
Exploded view TE Jack & Plug



These Quick Coupling Jacks and Plugs make connecting thermocouple circuits — *Simpler — Easier — Quicker* — especially when circuits must be broken frequently. The Polarized Connectors are made of thermocouple material with either screw fastened or soldered connection. Bakelite cover halves are screw fastened; have finger-grip pull. The lead wire openings clamp duplex wire securely—relieving strain from connections.

For more information about these Connectors, Panels, Thermocouples, Lead Wires and Accessories, Write, now, for Catalog Section 23-1.

FAIR LAWN — Thermo Electric CO., INC. — NEW JERSEY



NEW CONSTANT DIFFERENTIAL RELAY TYPE 6000

For purge systems, liquid level and specific gravity measurements.

Maintains constant purge rate regardless of down stream pressure changes
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- Eliminates supply pressure regulator
- Pressure rating 600 P.S.I.
- Supplied with differential indicator
- Standard flow rates available .5-1-2.5-25-50 S. C. F. H.

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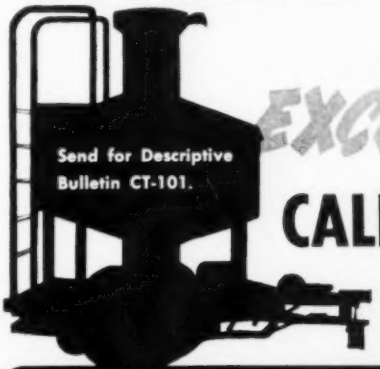

Send for Descriptive Bulletin CT-101.

EXCEL-SO CALIBRATING TANKS

Experience of REPETITION with hundreds of units has given us the "know-how" necessary to fabricate these REAL PRECISION INSTRUMENTS. Building, calibrating and guaranteeing a calibrating tank is specialized, painstaking work and is definitely "out" of the price-per-pound category.

All EXCEL-SO Calibrating Tanks are "Guaranteed Satisfactory," are designed to conform to the A.P.I. tentative code #1101, but may be furnished with such modifications as you, the customer, may require.

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se powered from the plant air supply, and presents no fire hazard. Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.

Circle No. 27 on Reply Card.

Proper Handling of Acids

Recommended Practice for Unloading Sulfuric Acid in Mixed Sulfuric and Sulfuric Acids From Tank Cars. Manual Sheet No. 1. 12 pages of the latest recommended practices for the unloading of acids and mixed acids from tank cars, including the unloading of inhibited sulfuric acid and oleum, also description of safety equipment, unloading equipment, sampling procedure, what to do about leaks, use of compressed air, unloading techniques and proper handling and care of fittings. Priced at 20c postpaid; order direct from Manufacturing Chemists Assn., 246 Woodward Bldg., Washington 5, D. C.

Heat Exchange Data

Heat Transfer Tables. 65 pages of engineering information in the form of graphs, flow coefficient tables, etc., prepared by Aero Products Division, American Locomotive Co., and priced at $1.00 per copy. Order direct from the American Locomotive Co., Schenectady 5, N. Y.

Literature Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature offered in this issue's advertisements.

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CORROSION — the great saboteur — works night and day making old storage tanks useless and necessitating costly repairs to new. In some sour crude areas, new tanks have been rendered useless in as little as 18 months.

Now, with steel again in short supply, you will have to get the maximum years of life from each tank so there may be more steel for defense.

NATASCO products will prevent corrosion from getting a start on your new tanks and prevent further corrosion on old ones.

NATASCO corrosion prevention products have been proved by years of successful use. NATASCO also provides experienced crews for the preparation and application of these products.

Learn how you can get the most in years of additional service from your tankage. Wire, telephone or write for complete information.

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For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New." You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

EXPANSION JOINTS. Bulletin 1041 offered by American District Steam Co., Inc. See adv't p. 1576.

FANS, cooling tower. Information offered by Hartzell Propeller Fan Co. See adv't p. 1589.

FIRE EXTINGUISHMENT, air foam type. Complete information offered by Pyrene Manufacturing Co. See adv't p. 1582.

FITTINGS, return bends. Descriptive Pamphlets offered by The Ohio Steel Foundry Co. See adv't p. 1670.

FITTINGS, welded. Catalog offered by Globe Steel Tubes Co. See adv't facing p. 1612.

FLOATS, high pressure. Bulletin 650 offered by W. H. Nicholson & Co. See adv't p. 1613.

GAGES, liquid level, reflex. Catalog 35 offered by Penberthy Injector Co. See adv't p. 1602.

HEATERS, gradation type. Booklet offered by Selas Corp. of America. See adv't p. 1574.

HEAT EXCHANGER TUBING, finned, aluminum. Bulletin offered by Wolverine Tube Division. See adv't p. 1564.

HEAT EXCHANGERS. Catalogs 1040 & 1145 offered by Young Radiator Co. See adv't p. 1599.

HEAT EXCHANGERS, air-cooled type. Bulletins offered by Hudson Engineering Corp. See adv't inside front cover.

HEAT EXCHANGERS, with brazed aluminum surface. Information offered by The Trane Co. See adv't p. 1595.

HEAT EXCHANGERS, scraped surface type. Bulletin PE-1 See adv't p. 1571.

HEAT EXCHANGERS, tank heater type. Bulletin 401 offered by Brown Fintube Co. See adv't p. 1537.

INFRARED ANALYZERS, for control of plant process steam. Information offered by Process Controls, a division of Baird Associates, Inc. See adv't p. 1688.

INSTRUMENTATION, graphic panels, etc. Bulletin x520 offered by Minneapolis Honeywell Regulator Co. See adv't pps. 1358-1359.

LIQUID LEVEL GAGES, automatic. Bulletin CP-3500 offered by the Vapor Recovery Systems Co. See adv't p. 1663.

MANOMETER, micro-pressure. Descriptive literature and prices offered by Hastings Instrument Co., Inc. See adv't p. 1650.

MECHANICAL SEALS, for pumps. Details offered by Byron Jackson Co. See adv't p. 1612.

METERS, positive displacement type, for gas. Bulletin 40-B-14 offered by Roots-Connersville Blower Corp. See adv't p. 1670.

MIXERS, top entering. Bulletin P-63 offered by International Engineering, Inc. See adv't p. 1693.

MIXERS, turbine type for dispersing, emulsifying, extracting, homogenizing, etc. Bulletin T-2 offered by U. S. Stoneware. See adv't p. 1675.

OXYGEN-NITROGEN GENERATORS. Catalog offered by Air Products, Inc. See adv't p. 1693.

PIPE CUTTING TOOLS. Bulletin No. P-2 offered by Vernon Tool Co. See adv't p. 1664.

PIPE FITTINGS, forged steel. Information offered by Watson-Stillman Co. See adv't p. 1630.

PROCESS EQUIPMENT, for refining, natural gasoline, chemicals. General catalog offered by Flint Steel Corp. See adv't p. 1690.

PUMPS, centrifugal. Information offered by Oil Well Supply Division. See adv't p. 1566.

PUMPS, controlled volume. Information offered by Milton Roy Co. See adv't p. 1599.

PUMPS, cycling jet. Bulletin 3600 offered by Penberthy Injector Co. See adv't p. 1602.

PUMPS, ejectors. Bulletin 512 offered by Penberthy Injector Co. See adv't p. 1602.

REFRACTORY LININGS. Brochure RC-28A offered by Johns-Manville. See adv't p. 1640.

REFRACTORY LININGS, for vessel walls. Bulletin offered by Rigidized Lining Corp. See adv't p. 1558.

STEAM TRAPS. Bulletin 152 offered by W. H. Nicholson & Co. See adv't p. 1673.

STEAM TRAPS, impulse type. Information and free sample offered by Yarnall-Waring Co. See adv't p. 1566.

SWIVEL JOINTS, ball bearing type. Application data sheet and catalog 51-C offered by Chiksan Co. See adv't p. 1671.

TANK CLEANING. Booklet offered by Oakite Products, Inc. See adv't p. 1591.

TANKS, cleaning, repairs and corrosion protection. Complete information offered by The Nelson Co. See adv't p. 1694.

TEMPERATURE CONTROLS. Catalog offered by Burling Instrument Co. See adv't p. 1661.

TEMPERATURE RECORDER, electric. Catalog G-143-B offered by The Electric Auto-Lite Co. See adv't p. 1669.

THERMOCOUPLES, and accessories. Catalog Section 231 offered by Thermo Electric Co., Inc. See adv't p. 1687.

TRANSMITTERS, differential-pressure type. Bulletin 09226 offered by Taylor Instruments Co. See adv't pps. 1578-1579.

TUBE CLEANERS. Complete details offered by Attool Manufacturing Co. See adv't p. 1664.

TUBING, aluminum, for heat exchangers. Booklet offered by Aluminum Co. of America. See adv't p. 1560.

TUBING, aluminum, small diameter. Booklet entitled "Utilitube" offered by Aluminum Co. of America. See adv't p. 1602.

TUBING, heat exchanger and condenser, copper alloy. Case histories offered by The American Brass Co. See adv't p. 1587.

TURBINES, general purpose. Twenty-page book B-3896 offered by Westinghouse Electric Corp. See adv't p. 1581.

TURBINES, steam. Full details and complete specifications offered by Twin Disc Clutch Co. See adv't p. 1584.

UREA SYNTHESIS. Information on new Inventa process offered by The Vulcan Copper & Supply Co. See adv't facing p. 1633.

VALVES, control. "Climax Controls Catalog" offered by Black, Sivalls & Bryson, Inc. See adv't pps 1562-1563.

VALVES, pressure reducing and regulating. Information offered by The Clark Manufacturing Co. See adv't p. 1550.

VALVES, for pumps. Catalog offered by Sims Pump Valve Co., Inc. See adv't p. 1602.

VALVES, safety. "5-Minute Brief" offered by Farris Engineering Corp. See adv't p. 1674.

Doing Pipe Fabrication Work?

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VERNON "Pipe-Cutting" PANTOGRAPH

Typical samples of pipe cuts

It's a big time and money saver! The PANTOGRAPH produces straight or beveled cut-offs, tee intersections, lateral intersections and miters. Handles pipe up to 24" diameter in any length. Eliminates the need for many expensive welding fittings, since intersections are cut to exact length on the pipe. All cuts are smoothly finished and beveled . . . no need for grinding, cleaning or hand fitting. The PANTOGRAPH is simple to operate . . . saves labor and material.

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EDITORIALS

Our Money's Worth in Research— 25 Years of API Fundamental Data

INTEREST is growing in the session at each annual meeting of the American Petroleum Institute at which reports are given on the status of the API fundamental research program. This is a natural outcome of the progress being made in the individual projects, two of which are at least 25 years old. The achievements in the work are cumulative and now provide all oil companies with a wealth of basic data which has already found wide practical application in laboratories and technological development work.

Many of the projects are at the stage where still more important results and data will be forthcoming from the research work, which is in two groups. One covers studies of the occurrence and recovery of petroleum from the ground; the second includes studies of the composition and properties of petroleum. The greater the attention of the oil industry can be directed to the work, the wider will be the practical application of the data and techniques which have been developed. The publicizing of the API program is the primary purpose of the sessions on fundamental research at the API annual meetings.

The progress in the work in the Group Two projects was presented this year. A partial listing only, of the contributions to the practical technology of the industry resulting from these studies in the composition and properties of petroleum includes:

The identification, isolation and analysis of many hundreds of the hydrocarbon compounds occurring in crude petroleum. The preparation, by synthesis, of pure samples of a great many of these hydrocarbons, and making them available for further study in oil company and other scientific laboratories. The resulting knowledge of the properties of these hydrocarbons in the gasoline range has aided greatly in our production of aviation gasoline. The study of the behavior of the pure low molecular hydrocarbons used in engines has contributed materially to the knowledge of automotive fuels.

The synthesis and study of the hydrocarbons found in the heavier fractions of the barrel of crude has aided the oil companies in their study of techniques to manufacture improved lubricating oils and waxes. The pure hydrocarbons produced by synthesis also serve as standard samples for calibrating the new spectrometric instruments used today in the analysis of petroleum products. They also provide the material for a new project in the API group, the development of fundamental information on the thermodynamic properties of hydrocarbons and some of their derivatives. In still another project in this general group, sulfur compounds occurring in petroleum are being studied and pure samples of these compounds made available.

Laboratory techniques developed through the API projects have been applied in oil company laboratories, and in at least one instance, a commercial extraction process has been developed from an analytical tool originally developed in one of the projects. This is the Sun Oil Co.'s recently announced Arosorb process for the commercial application of highly selective adsorptive properties of silica gel.

In the other group of API research projects, which will be reported on at next year's API meeting, those having to do with the occurrence and recovery of petroleum from the ground, equally valuable fundamental data has been secured. A project which began as a study of the behavior of gas in the ground as an instrument for oil production, developed information which, applied commercially, has led to the recovery of millions of barrels of distillate produced with gas under high pressure conditions, which would otherwise have been lost.

The API program is unique in industrial research work in this country, and it is being carried on at a very low cost in relation to its importance. Since the inception of the program in 1927, the API has administered the spending of over $5,000,000 in the form of contributions from many oil companies and individuals. The data and information developed through the projects, by contractural arrangements of the API and the research institutions doing the work, is dedicated to the public. It is freely available to all oil companies and industrial and scientific institutions of all kinds, here and abroad.

The API fundamental research program should be continued and even expanded. The rapid technological growth of the petroleum industry brings up new instances where basic data, of the type developed in the API program, can be of great service to the refining and producing companies in their practical operations. Continuing the sessions at the general API meeting, where progress in the research program is reported, will serve to bring a wider knowledge of the work and still further extend its usefulness.

—V.B.G.

The Secondary Storage Report

THE publishing by the Bureau of Census, in cooperation with the oil marketing companies, of regular monthly data on the volume of inventories of the four major products in the hands of local distributing agencies, fills a long time need. The reports are even more valuable because they include data on secondary storage capacity for large and small marketing companies, even though the data is not segregated by type of company.

As was to be expected, the volume of products in local distributors' hands is small as compared with that in the storage tanks of the refiners and in the large terminals. It is the strategic position of this type of product inventory that makes data concerning it more valuable. It will reflect changes in consumer demand much more quickly than primary storage. For example, having the actual data on the volume of heating oils in local distributors' storage along the East Coast, should provide the answer to predictions of coming shortages that often arise in this territory, sometimes politically inspired.

The latest Census Bureau report, for release Oct. 23rd, gives data as of Sept. 1, which is thus 8 weeks old before it can be put in the hands of the oil companies. Expediting the report to provide more up-to-date figures will make it more helpful to all concerned. The Bureau is to be commended for so promptly arranging to start this reporting service.

—V.B.G.

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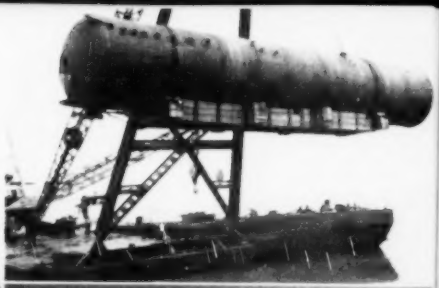

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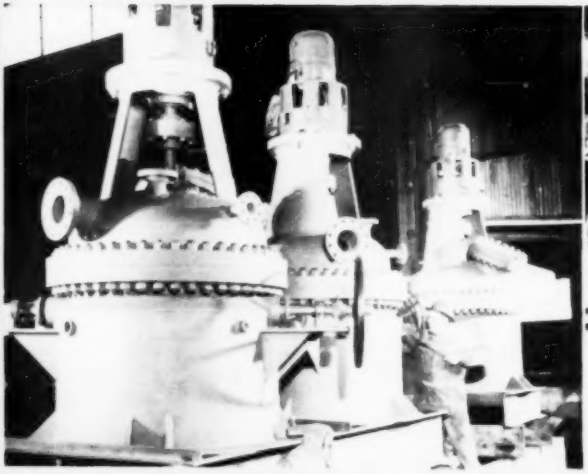

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